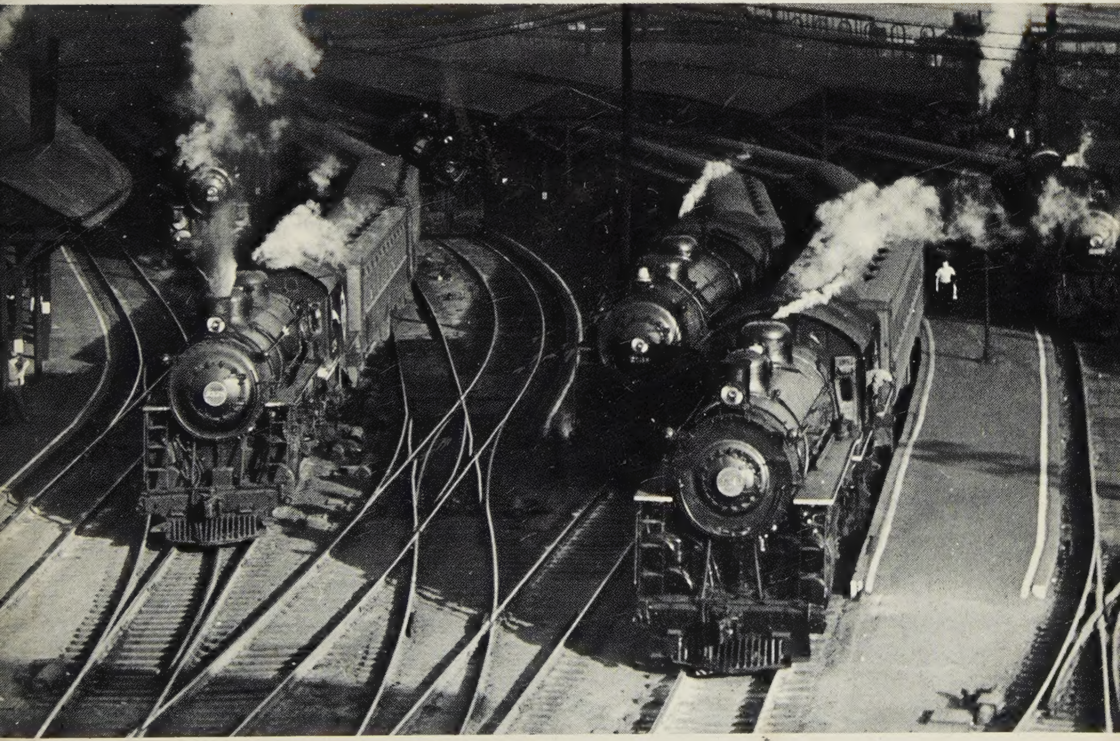
PASSENGER TERMINALS AND TRAINS

BY JOHN A. DROEGE



Introduction by George W. Hilton

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AT the noontide of the American passenger train, the general superintendent of the passenger-oriented New Haven Railroad addressed himself to the rail carriage of people in a lucid book that could be comprehended by anyone (but that, as *Railway Age Gazette* noted, would be "wanted in every railroad officer's library"). From the size of waiting rooms to the demeanor of redcaps, from the contest between A.C. and D.C. electrification to the menus of dining cars, no subject pertinent to the world of passenger terminals and trains in the year 1916 escaped the experienced eye of John A. Droege. Thus unconsciously he penned what is in retrospect a masterful history of how the railroads reacted when a restless, growing America besieged the gates of Union Station, intent upon purchasing tickets to everywhere from Passaic to Pasadena. Kalmbach has faithfully reproduced all 410 pages of the original edition of Droege's Passenger Terminals and Trains — which include 25 track diagrams, 31 station floor plans, 163 photos, and an index — and has taken the measure of the volume in a special introduction by Prof. George W. Hilton. An outstanding contribution to railroad literature.

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PASSENGER
TERMINALS AND TRAINS

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BY

JOHN A. DROEGE

GENERAL SUPERINTENDENT, NEW YORK, NEW HAVEN AND HARTFORD RAILROAD.
AUTHOR OF "FREIGHT TERMINALS AND TRAINS."

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THIRD IMPRESSION

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INTRODUCTION

THE passenger train is moribund. The heart still beats, but the brain waves are still; and those of us who loved it gather about the deathbed, either to propose euthanasia, to advocate a peaceful natural end, or to seek a heart transplant (in the form of a subsidy) in one last desperate try to prolong life. The time for the obituary is not far off, probably no later than 1975, whatever the physicians may elect to do.

Obituaries are likely to be biased by emotional considerations. Memory will dwell on a fine rockfish dinner on the Chesapeake & Ohio in the New River Gorge, not on a Pennsylvania conductor shaking one awake at Altoona to check his ticket for Washington. One will think of arriving in Chicago on the minute on the *Capitol Limited,* not of almost being dispatched in a collision on the *Erie Limited* at Hornell. The cinder in the eye at North Platte will be forgotten, but the ferry ride into San Francisco will remain in memory for life.

The obituaries are sure to be written by the passengers. Far better it is to have a document of the passenger train from the years of its glory, and one written by a railroadman for the guidance of his fellows. And here we have it in the form of PASSENGER TERMINALS AND TRAINS by John A. Droege, published in 1916, almost exactly when the railroad industry reached its peak and began its long decline.

Droege was well qualified for his task. He was born in 1861, entered railroad service in 1880 with the Baltimore & Ohio, then moved on to C&O, Norfolk & Western, and Southern, serving variously as stenographer, telegrapher, dispatcher, yardmaster, and trainmaster. In January 1899 he became trainmaster of the Lehigh Valley in charge of the line's terminals in New Jersey, an experience that manifested itself in the excellent chapter on waterfront terminals in this volume. The following year Droege became division superintendent at Sayre, Pa., but in December 1904 he moved on to the superintendency of the Providence Division of the New Haven, the railroad with which he was to serve out his long career. In 1912, while he was still a division superintendent, Droege produced *Freight Terminals and Trains,* the first of his two books. This was successful enough that McGraw-Hill commissioned him to do a companion volume on passengers, which he brought forth in 1916. Droege was then superintendent of the New Haven's lines west; in 1917 he became superintendent of the New York Division and of the company's New York terminals. In 1925, the same year he produced a much-expanded second edition of *Freight Terminals and Trains,* he was promoted to the general managership of the railroad. He remained the New Haven's chief operating officer—becoming vice-president of the company in 1929, and superin-

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tendent of the line's highway subsidiary in 1930—until his retirement in November 1931. Look not in *Railway Age* of the late 1930's for his obituary, however; Droege, adding longevity to success, died in Orlando, Fla., on March 5, 1961, just beyond his 100th birthday.

As a manual of how-they-did-it in passenger service, the book speaks for itself. Droege wrote from long experience, which is evident on every page. No academic writer he; nobody asked *him* if he'd ever met a payroll! The question arises, however, whether he recognized the economic forces at work on the passenger train as he wrote.

The passenger train, apart from its temporary resurgence during World War II, had a typical secular decline. It declined first relatively, then absolutely, and is now in the process of passing out of existence. The relative decline began in the mid-1890's with the building of the rural trolley lines in New England and the interurbans elsewhere in the United States. These attracted much of the local passenger traffic (which seems not to have interested Droege much, in any case), but the growth of long-distance traffic caused the aggregate figures on passenger volume to increase until 1921, when the decline turned from relative to absolute. Thereafter, except for the war years, passenger volume fell virtually monotonically to the present. According to the ICC's formula, passenger service as a whole remained profitable through the 1920's, but promptly plunged into the red in 1930, where it has remained ever since—save again for the war years.

One of Droege's most interesting observations in this volume is that passenger service was already unprofitable. He treats this as unquestionable: "The passenger business of American railroads does not pay." If so, the ICC formula was then, as it seems to be doing now on the basis of experience of railroads that are giving up passenger trains completely, understating the costs of passenger operations. If passenger trains were being operated at a loss even before the absolute decline began in 1921, railroadmen should have been able to foresee the eventual decline and extinction of the passenger train. Droege, whatever may be said for his descriptive talents, was no seer. He treated the passenger deficit merely as part of the public service obligations of railroads, and obviously saw no prospect of the public's turning to alternatives for intercity travel. He anticipated indefinite secular growth of passenger traffic, worried about the adequacy of existing stations to handle the crowds of 25 years hence, and defended facilities such as the unused loops at South Station in Boston, built in anticipation of passengers who never came.

Droege's attitude toward the future undoubtedly was typical of passenger men of his era. Such attitudes explain in part why the decline of the passenger train was so lengthy. Railroadmen widely believed that passenger service was an obligation to the public, a source of professional pride, and an advertisement for the railroad. As in most declining activities, there existed a fairly universal article of faith that things might be bad, but they would get no worse: the limited would not go the way of the local. Such attitudes, together with the restrictions on exit posed by the regulatory authorities, and the irrecoverability of investment in many of the passenger facilities, combined to push rail passenger service more fully beyond the point of hopelessness than any other activity in recent economic history.

Droege, significantly, put "terminals" ahead of "trains" in his title. His background was such as to make him a thorough expert on stations, and what went on in them. Whether Droege intended it or not, the book is a volume in architectural criticism, as well as a manual of operations. Droege made no threat to Sir Banister Fletcher's reputation as an architectural historian. Like most who write on architecture, he expresses maximum enthusiasm for what is the height of fashion in his own day. In 1916, Daniel H. Burnham's concept of the "City Beautiful"—Roman buildings in spacious parklike settings—dominated the design of large buildings. The adaptation of this to railroad stations was particularly obvious; a Roman vault was ideal for a waiting room, and the Romans' taste for statuary incidental to architecture lent itself to memorializing Gen. William W. Atterbury as well as it did Julius Caesar. This period produced its masterpieces, notably the Kansas City and Washington union stations and the two New York terminals; but most of what seemed the highest flowering of railroad architecture to Droege now looks rather sterile. The typical Roman station came to look progressively more like a mausoleum as the passengers deserted it.

Again, Droege is typical of architectural writers in showing little interest in what immediately preceded the architectural fashion of his own day. The stations built just before the Chicago World's Columbian Exposition of 1893 made Roman architecture fashionable are now looked upon as the best examples of the traditional and the functional that railroad architecture embodied; but Droege, apart from setting down some favorable observations on Broad Street and St. Louis Union stations, pays little attention to the Victorian stations. Typically, he praises North Western station in Chicago—today regarded as a pedestrian classical building—as an ideal mixture of beauty and functionality, whereas the two Chicago stations currently considered to have genuine architectural merit, Central and Grand Central, he doesn't mention at all.

For pure architectural history, we turn to Carroll L. V. Meeks's *The Railroad Station* (Yale University Press, New Haven, Conn., 1956). Meeks had the advantage of thorough academic grounding in architectural history, and the catholicity in taste the job required. He was able, too, to include several major stations built since 1916 (notably the Chicago, Cincinnati, Los Angeles, and New Orleans union stations), and he could see both beauty and genius in a good trainshed. Droege characteristically liked the Bush slotted trainshed, then in fashion, and considered the balloon trainshed, now so much revered, as a Victorian abomination.

Thus, as an economic seer or as an architectural critic, Droege has little to be said for him. He purported to be neither, of course. He did purport to be a railroadman, and an expert on passengers, and none will gainsay him that. Let us finally give him his laurels as a social historian, too. As we read his pages, we walk the platforms, observing an institution we can never experience again. We see the thousand trains a day at Oakland Pier, the eight boats an hour in the Lackawanna's slips, the 2,387,545 pieces of baggage in 1904 at St. Louis Union Station, and the 38 million passengers in 1913 at South Station. The study of history is one of the most valuable pursuits of the intellect, partly to show us the origins of present problems, partly to preserve our cultural heritage, and partly to let us relive what is irretrievably vanished. On all grounds, Droege made his contribution, however unconsciously, and he richly deserves the honor of posthumous republication.

George W. Hilton

Washington, D. C.
July 21, 1968

PREFACE

Following the publication and kindly reception of "Freight Terminals and Trains" (1912), suggestions were made that the whole field of terminal and train operation should be covered by the compilation of a companion work treating similarly of the passenger service. The author's efforts to cover a field heretofore not specifically treated, have resulted in the following pages.

The general plan of "Freight Terminals and Trains" has been followed. While there must be some interlocking of allied branches, duplication has been avoided wherever practicable, and the work arranged with a view to producing two companion volumes covering the operation of freight- and passenger-train service, the design, construction and maintenance of terminals and accessories, with a discussion of the plans of organization and operating methods co-incident thereto.

To describe all existing passenger terminals was, of course, out of the question. It has been the aim, therefore, to include only such descriptions, views and plans as embody typical or unique features, possessing educational value. Consequently, some of the larger and more important terminals have been omitted while others of seemingly less importance have been included.

In a field where there is such a diversity of opinion and practice, and where "standard practice" is yet to be established, it has seemed advisable to include all possible information and to quote freely from the published views of experts, both those in confirmation of and those conflicting with the views of the author. In most instances acknowledgment is made in the text. The author's appreciative gratitude is due particularly to the *Railway Age Gazette;* and also to *Engineering News;* the *Engineering Record;* the *Railway Review; Railway and Locomotive Engineering,* and other railroad and technical periodicals. He is indebted also to many railroad officers and specialists for information, assistance and helpful criticism. For unusual and specific constructive aid and review, he is obligated to Samuel O. Dunn, editor of the *Railway Age Gazette;* William J. Cunningham, professor of transportation, Harvard Graduate School of Business Administration; C. B. Breed, associate professor of civil engineering, Massachusetts Institute of Technology, and B. B. Adams, associate editor of the *Railway Age Gazette.* He also wishes to express appreciation for assistance lent him by Charles W. Foss, associate editor of the *Railway Age Gazette,* and by J. E. Slater, of the accounting department of the New York, New Haven & Hartford.

New Haven, Conn.
July, 1916.

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PASSENGER TERMINALS AND TRAINS

CHAPTER I

GENERAL PRINCIPLES

The passenger business of the American railways has always been characterized by the word, "service." It is noted of Americans that they want and are willing and able to pay for service, and there are few places where this is better shown than in connection with the comfort and convenience of travel. Critics of our great transportation system or advocates of government ownership may point out that on the state owned lines of France, Germany, Australia or other countries, passengers are carried at lower fares than here. It is true that 75 per cent. or more of the passenger traffic in these countries is carried at rates equal to only one-quarter or one-half our own, but it is also true that the service furnished at these rates is so far inferior to that supplied on the railroads of this country that it would not be tolerated for an instant by the American public. The comparatively small number of passengers who do secure accommodations equivalent to those demanded by the average American patron pay rates as high or higher than those charged here.

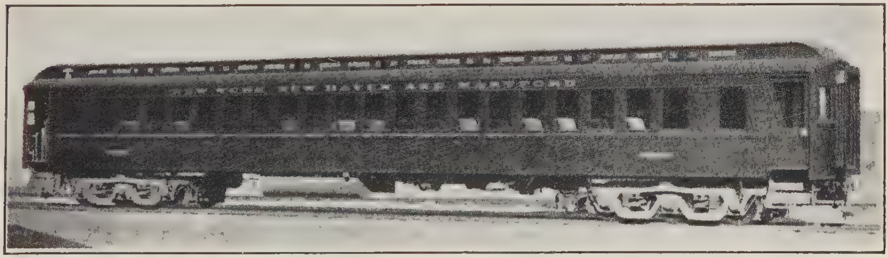

FIG. 1.—A modern all-steel coach.

It is almost axiomatic that the passenger carrying business of most steam railroads is not entirely self sustaining. In the case of the state-owned lines of foreign countries this is largely a matter of policy, it being realized that practically all people ride in passenger trains at some time or other whereas all persons do not ship freight. Indirectly, they may pay freight charges, but a passenger fare is a very direct charge, while the freight rate at best is but a most intangible portion of the price of a commodity. Because the direct charge is more apparent, its amount is lowered and the difference made up in the larger indirect rates on freight, paid directly by the shippers, it is true, but by a smaller portion of the population.

In this country the railways have always tried to make all portions of their service self sustaining, and in this policy they have been supported by the highest courts of the land.[1] The passenger business, nevertheless, has not always been self sustaining. In the case of road after road it has barely earned its direct or out-of-pocket costs while the freight rates, lower at least by half than those of most foreign countries, have paid the interest on the investment or the dividends. In a number of states the maximum fare which may be charged is two cents a mile. It has been absolutely proved that the larger portion of the passenger business in these states is carried at a loss. Except in the case of commuter service or excursions where large trainloads are practically guaranteed it is next to impossible to carry passengers on steam railways at two cents a mile and make a profit. This does not imply that all commuter traffic pays for itself, for most of this business is handled at rates approximately one cent a mile rather than two. As showing what some railways are up against in connection with their passenger business, it is worth noting that the New Haven has to pay 29 cents for each passenger it brings into the Grand Central Terminal in New York. The Baltimore & Ohio in the fiscal year ended June 30, 1911, paid out 82.39 per cent. of its passenger receipts in expenses of passenger train operation. In the year ended June 30, 1913, the percentage was 106.23, so that it actually

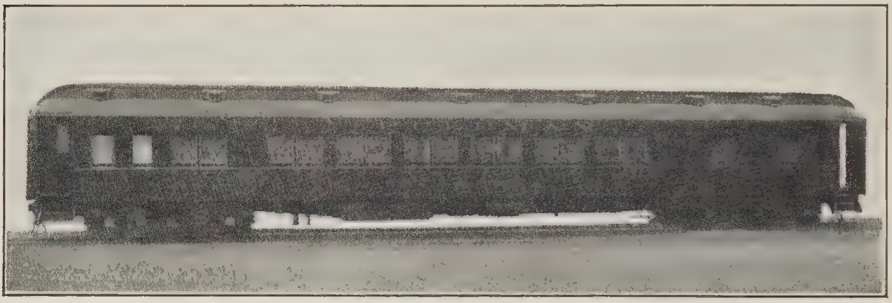

FIG. 2.—All-steel Pullman car of recent design.

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[1] This does not mean, however, that every train or every branch line must pay its way. The courts have ruled that in certain cases unremunerative trains must be run for public convenience, the losses to be absorbed in the earnings of remunerative trains.

cost the company more to carry the traffic than it received. The Pennsylvania Company in 1907 operated its passenger traffic at 74.4 per cent. of the passenger receipts, but in 1913, although the revenues had increased from $31,000,000 to $38,000,000, the percentage was 92.6.[1]

There are many reasons why the passenger business of American railroads does not pay; they nearly all come down to the simple fact that the American carriers, as far as passenger traffic is concerned, have ever made service their watchword instead of profits. By force of public opinion and competition they have introduced block signals; they have rock ballasted their roadbeds; they have introduced steel cars; they have installed electric lighting systems on their equipment; they have bought larger

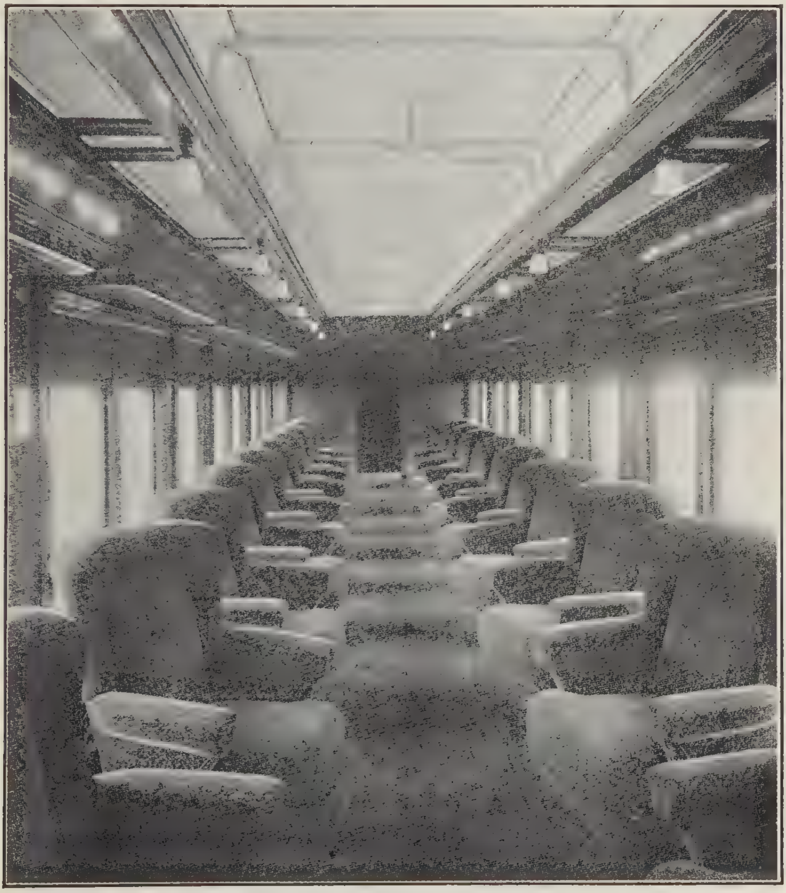

Fig. 3.—Interior of Pullman chair car.

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[1] The degree of truth in these figures depends, of course, upon the accuracy of the division of expenses between passenger and freight service.

engines and increased the speed of their trains; they have built magnificent palaces for stations; they have spent their money in observation cars and buffet smoking cars or even in providing libraries, baths, stenographers, valets, maids and barbers free or at but small additional cost. In short, they have done all that could be done to attract and please the public. It is always service, service first and profits afterward.

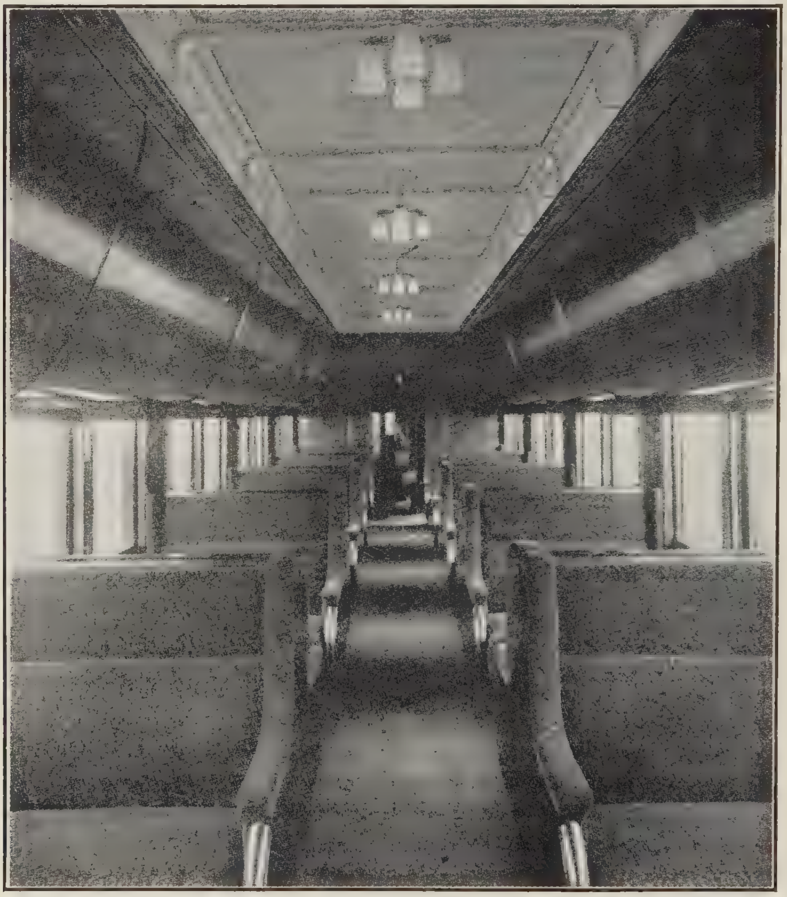

Fig. 4.—Interior of Pullman sleeping car.

But these things do not make dividends. Gravel ballast is considered every bit as economical as rock and in first cost it is much cheaper; but it is dusty and must be replaced. Faster schedules do not earn more money—they burn it—but the public wants fast trains. Steel equipment is expensive; wooden equipment is cheaper, more economical and if it is replaced must frequently be cast aside when there are yet many years of reliable service ahead of it. Steel cars, however, are safer and the public wants them. Magnificent stations do not earn one cent more revenue, their cost is great and they are costly to maintain, but if these mighty edifices will please the public, they must be built.

The problem before the American railroads today is to determine how they can best make their passenger traffic lucrative again. At the suggestion of the Interstate Commerce Commission they have proposed to increase their fares or to make charges for the extra services rendered. They have had some success along these lines and are still engaging in the

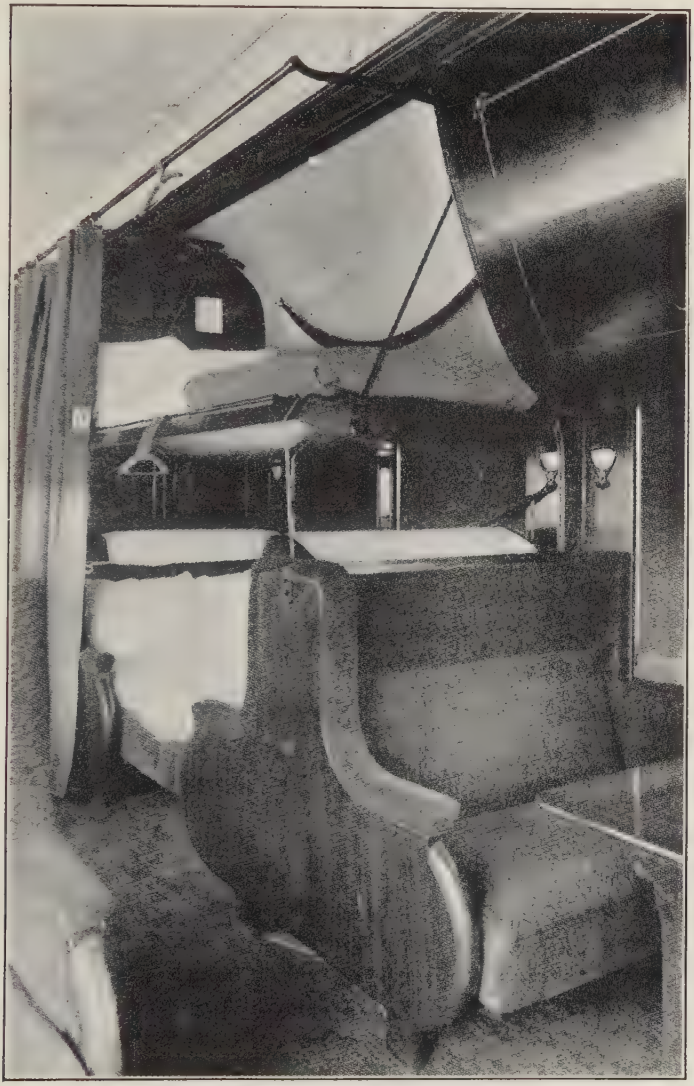

FIG. 5.—Interior of sleeping car, showing berth made up.

work. With both legislatures and state and interstate commissions to convince, their task, to say the least, is hard. It is not the purpose of this book, however, to consider either passenger fares or public regulation. It is its purpose, rather, to consider the passenger service itself, to take up the design of the massive terminals through which the passenger traffic passes, to determine what is good and bad in the operation of these terminals and to deal with the operation of the trains which use them.

The passenger terminal has been aptly described as the city gate and for some of the newer and larger stations it would, indeed, be hard to find a term more fitting. "The railroad terminal is the city gate. Without, it rises in the superior arrogance of white marble from an open square as an architectural something. It has broad portals and through these portals come and go a host of folks in cabs and carriages, in trolley cars and elevated trains—folk afoot. Within, this city gate is a thing of stupendous apartments and monumental dimensions—a thing not to be grasped in a moment. In a single great apartment—a vaulted room so great as to have its dimensions sink into distant vistas—are the steam caravans that come and go. It is a busy place, a place of an infinite variety of business . . . . Rest? Oh, no. There is no rest at the city gate."[1]

The American railroads have frequently been criticized for having lavished such great amounts of money on their passenger stations, or as one authority has aptly said, they have indulged too much in "gilded stairs and marble halls." It is certainly true that this is one thing on which the railways do not skimp. The recently completed Union Station at Kansas City cost $40,000,000 of which $11,000,000 was spent on the station itself. It has been said that some of the lines which use the terminal pay more for the privilege than they receive in gross receipts from their entire Kansas City passenger traffic. The New York Central's passenger terminal facilities in New York when completed will probably have cost approximately $200,000,000, sufficient to build 2,000 miles of double track railway line costing $100,000 a mile. It has been estimated that the fixed charges, taxes and depreciation will total $20,000,000 yearly and the operating and maintenance expenses $3,000,000 more.[2] The total passenger receipts of the New Haven and New York Central from New York City traffic certainly do not total much more than this. The Pennsylvania's terminal on Manhattan has cost between $110,000,000 and $120,000,000. One authority[3] has made the statement that the terminal

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[1] Edward Hungerford, in an article in Harper's Weekly.

[2] The New York Central expects sufficient income in the form of rents on a large portion of this property, however, to pay a large share of the fixed charges. See Chapter VII.

[3] L. C. Fritch, chief engineer, Chicago Great Western, in a paper read before the Canadian Railway Club, January 14, 1913. See Railway Age Gazette, January 17, 1913.

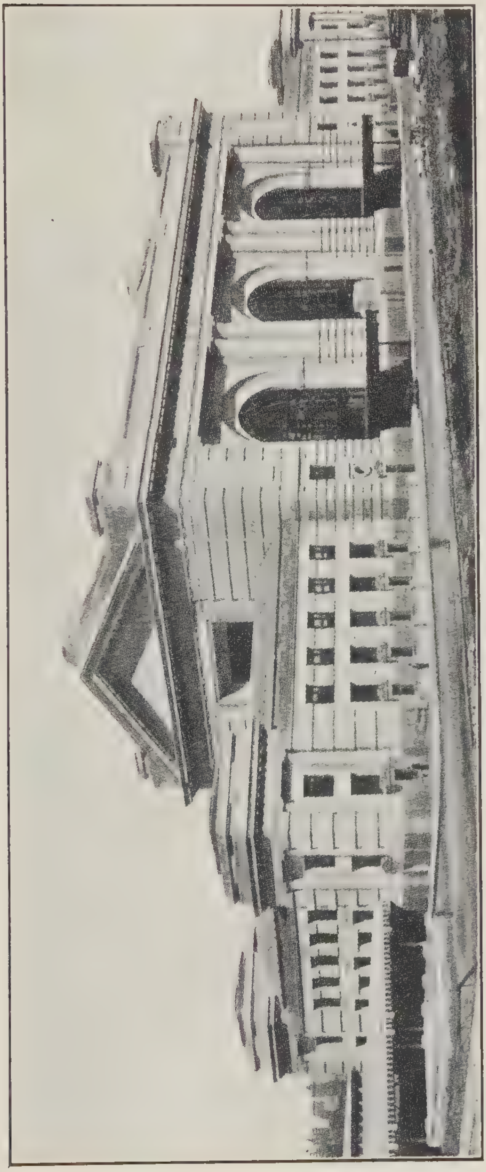

Fig. 6.—Union Station, Kansas City.

charges are about equal to the entire gross receipts of the Pennsylvania and Long Island from passenger traffic in the city. It has been further shown that the passenger terminals in which the Pennsylvania Railroad is interested in Washington, Baltimore, New York and Philadelphia have a combined value of $178,000,000, equal to an average of about $800,000 per mile for the 223 miles from New York to Washington. The fixed charges alone on this investment total $40,000 a mile on the same line.

The railroads, however, have some justification for having spent so much money on their passenger terminals. Not the least reason is the fact that the railway passenger station is the main entrance to and the main exit from the city. Civic pride demands a fitting gateway and it is in the best interests of the railroad to do its share. One of the remarkable features of American life has been the rapid growth of its communities. The average passenger station under such conditions has rarely retained its adequacy more than 25 or 30 years. It has been practically impossible to anticipate the exact degree of growth of business, and the cases are few where the railroads with all their foresight have been able to anticipate the future sufficiently. That explains why many of the stations now being built seem so enormous. It is quite possible that 25 years from now we shall look upon them, as magnificent as they now seem, as relics of a bygone age, woefully inadequate and out of date.

Passenger terminal design in the United States has been characterized by the use of wide areas and of a very general tendency toward massiveness. The waiting room of the new Union Station in Kansas City has an area of 26,100 sq. ft. The Union Station in Washington has a similar area, 26,280 sq. ft. in size. The area of the waiting room in the North Western Station in Chicago is 25,000 sq. ft., but in the Pennsylvania Terminal in New York there is a space, 33,000 sq. ft. in area and 150 ft. in height. The other rooms in each of these stations are, of course, in keeping with the waiting rooms. It will emphasize these figures to note that in the Liverpool Street Station in London, handling at least twice the business of any of the terminals mentioned and the busiest station in England, there are four waiting rooms with a combined area of 3,000 sq. ft. It is but fair to say, however, that more waiting space is necessary in these particular American stations because trains are not so frequent.

The words of the Honorable Evelyn Cecil, a director of the London & South-Western and a delegate to the meeting of the International Railway Congress at Washington a few years ago, give an interesting expression of the views of an Englishman in this regard:

"What strikes me most about the stations (in America) is the space. In most cases in England we are so confined for room. My first impression of an American depot was that it is extremely grand and palatial, and the comfort of the public more considered than in our stations at home. Of course, the question of distinction in classes makes this much easier. The waiting room, like a grand central hall, creates a decidedly favorable impression, and the heating and lighting is all that could be desired. In fact, I was astonished at the prodigality of the use of the incandescent electric light. The platforms not being raised also simplifies the construction in America considerably. We had the means of thoroughly inspecting the South Union Terminal at Boston and the traffic there seems to be about the same as at Waterloo station, and yet they have not only three times the amount of tracks and space now, but have been able to make provision for coping with almost any amount of traffic in the future, with the double loop,[1] the subway and other arrangements. When our English stations were built, it was impossible to foresee what the traffic would grow to, and building in this country to meet any contingency seems a wise plan. It is much to be regretted that former generations were not more foreseeing. This thinking of the future is evidently very much of the construction of the smaller stations, railroad sheds and yards. While we build a solid structure that will last for an indefinite time, here a much cheaper building is rushed up with a view of removal within 10 years if necessary, should later contingencies arise."

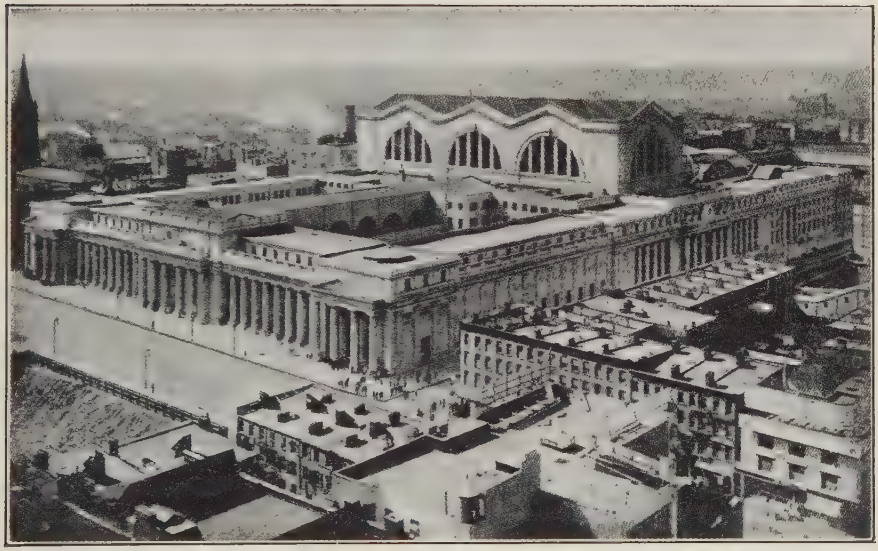

FIG. 7.—Pennsylvania Station in New York City.

The opinion has often been expressed that it is only in recent years that the possibilities of the artistic in passenger terminal design have been fully realized. There can be no doubt that the new stations are far superior both as to exterior and interior appearance to their predecessors. But, as a general thing, this does not necessarily prove, as some have thought, that the railways have turned a new leaf and now give their terminals an added architectural or æsthetic importance. Passenger terminals were built years ago that were models of architectural beauty for their period. The North and the South Stations in Boston, the great Union Station in St. Louis or the Reading and the Broad Street Stations in Philadelphia even now stand forth among some of the newer terminals. If they and some of the other stations of their time do not stand in the foremost rank among modern terminals, it certainly is not because there was not sufficient thought and care expended on their design. Stations have shown their improvement—and it certainly is a great one—rather because there has been a marked advance in architecture in the past two or three decades as to which there can be no question. There is hardly a city in which the newer buildings are not head and shoulders, physically and architecturally, above the older buildings about them. One has but to compare the ugly postoffice buildings built sometime ago in New York, Philadelphia, Boston or other cities with the structures that are being built today to emphasize that point. As far as railroad stations are concerned, however, the architects have had the advantage that in recent designs they have not had to worry about the great arched train shed which at one time indicated the character of every important railway terminal; they can now choose among the butterfly, the umbrella or the Bush types of sheds. The old arched roof was always dirty, ill ventilated and poorly lighted and its influence was contagious.[1] The new sheds, being cleaner, permit of cleaner stations and the exercise of much talent in the interiors that once would have been wasted. The cleanliness of electrification has further permitted wonderful results in the case of the Grand Central and Pennsylvania Terminals in New York City.

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[1] See Chapter V. These loops have not been put in use.

It has been said that on the average a terminal lasts about 25 or 30 years. The Broad Street Station in Philadelphia is an example. This station has now been in its present form a few years more than two decades; it is significant that the Pennsylvania Railroad has recently electrified its main line to Paoli, 20 miles out, for suburban service and to relieve the strain on the terminal. The Grand Central Station in New York has been remodelled four times in 40 years. It has now been made perhaps the best and largest passenger terminal in the world. Railway men find it interesting to speculate whether the present structure will be adequate or even in existence 20 years from now.

It is interesting to consider some of the factors determining the life of a terminal. The two most important elements are the development of the railway train and the astonishingly rapid growth of the communities. It is very easy to see how a station may become inadequate for the trains which use it. A train shed and platforms built for trains of eight cars will not serve trains of 12. This is the case at the North Station in Boston now, and is especially noticeable on days of heavy travel; a long train frequently has to be left partly on the interlocking, thereby tying up several tracks instead of one. At Broad Street, the train shed is too short; the space for platforms, however, is ample and the difficulty easily overcome by a number of umbrella sheds extending out beyond the large main arch. More frequently the life of the terminal is determined primarily by the growth of the community and the increased demand put upon the railway's passenger facilities. This means, simply, that the increased business offered to the carrier proves more than its station can handle efficiently, thus making it only a question of time as to when the station shall be replaced.

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[1] Nevertheless, the city of Providence through injunction suits held up the use of its new station two years and *compelled* the installation of the big train shed.

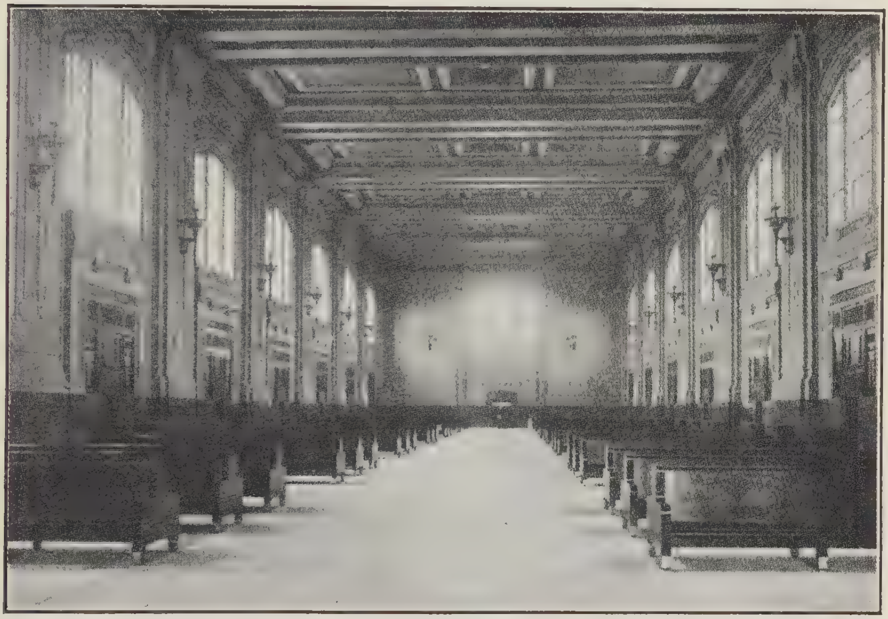

Fig. 8.—Waiting room of Kansas City Station.

Railroads are sometimes led to replace their stations for other reasons. They may feel that a particular station is not fitting for the town it serves or not up to what is felt to be the standard for the system. One can easily imagine a case in which a station was built by a small or poor railway that later increased in size or was absorbed into a larger system. The same line in its new position or the wealthy owning road may deem it wise to build a terminal more suited to its size and standing. Few railroads are in a position, nevertheless, to replace stations performing an adequate service because a newer station may be more comfortable or more beautiful.

The late President Finley, of the Southern Railway, once expressed this well in an address before the American Institute of Architects on December 16, 1909:

> We must now consider the passenger station from the viewpoint of railway housekeeping. Let us assume that a certain city is provided with station facilities that are not quite up to the standard of similar facilities in some other places of approximately the same population and commercial importance. They are not such as the community would like to have, and they are not such as the railway management would consider ideal. The community believes it is entitled to the best of everything. It does not want a station that will be merely as good as one in a nearby town of the same size. It wants a better one. It would like to have the best and most beautiful station of any town of the same relative importance in that whole section of the country, and it does not hesitate to say so through its municipal officers, its commercial organizations and its newspapers.
>
> The railway manager is in much the same position as the housekeeper when the old piano, which is still fairly good as a musical instrument, has had its case battered and scratched and the daughter of the family demands a new one. If he could draw on unlimited supplies of money he would like to provide every city on his line with an architectural monument, and every little way station with an artistic gem. It would be a splendid advertisement of his road, and the American Institute of Architects would hail him as the greatest railway manager the world had ever seen. But, just as the housekeeper who would like to buy a new piano must think first of the monthly grocery bill, of the needs of the family for clothes, of the leak in the roof, and, possibly, of the necessity of an addition to the house, so the railway manager, whose resources are always strictly limited by the earnings of the road and its credit, must think of his operating expenses, fixed charges, and taxes, and of the need of additional tracks, more cars, and additional and more powerful locomotives. He is glad to contribute to the gratification of the artistic taste of the public, but his first duty is to haul the public and its property over his lines. It may well be that the money which the new station would cost, if expended for additional tracks, would be far more beneficial to their city as a whole than would be the most splendid passenger station to which they could aspire. In that case their interests and those of the railway are identical, and it is better for all concerned that they should put up with the not entirely satisfactory station facilities for a few years longer rather than the more vital improvements should be delayed. Capital invested in passenger stations in excess of the amount necessary to provide adequate and proper facilities for doing passenger business is unproductive.

Public regulation is always an important factor in passenger terminal progress. There are some few cases where the public authorities have ordered the building of new stations and in which the decision has meant a structure far beyond the need of the town with consequent hardship to the railroad. Public regulation appears at its best in terminal design, however, in connection with the elimination of grade crossings. Station after station can be named, Worcester, Mass., Wichita, Kans., etc., which was built as part of a broader scheme of grade crossing elimination. In some cases the plan results from the order of the public body; in others it is a matter of mutual agreement, possibly with the state law or the jurisdiction of the public service commission having control over the final arrangement of terms as between railroad, street railway and city. The plan for elimination of grade crossings at Worcester, Mass., incidentally, was under consideration for 20 years before the final decisions were reached. Laws providing for electrification are likewise important but it would be difficult to say what effect they might have, for but one terminal in the United States has been influenced by them, the Grand Central Terminal in New York.

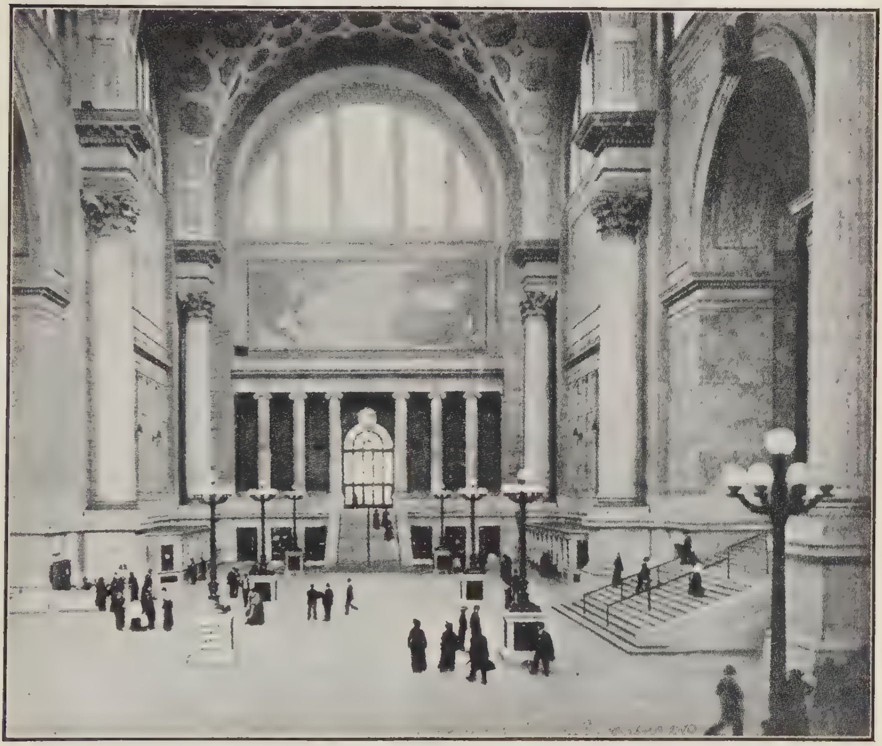

Fig. 9.—General waiting room of Pennsylvania Station, New York.

It usually happens that those cities which have the best passenger terminals are on the whole those which have the newer ones, the experience of any particular city in this respect depending largely upon the strength of the lines which serve it, their competition with each other or with lines serving adjacent cities, the degree of civic pride existing, the rapidity of the city's growth or the action of the public regulatory bodies.

It was the opinion of the late Walter G. Berg that:

> "It will prove better to follow, as a rule, well-established styles as precedents, applying the same principles modified to suit each individual case, in preference to attempting to produce something absolutely new and unique, which generally results in presenting for the edification of the inartistic public a kaleidoscopic conglomeration of architectural odds and ends from different climes and centuries."

That a person of Mr. Berg's standing had justification for speaking thus is not to be denied. It does actually seem in many cases as though the terminal designers had almost refused to profit by the experience of their predecessors or rather by the experiences of the operating officers who profited or suffered from those experiences. It is for that reason, perhaps, that such stations as the Broad Street or the Philadelphia & Reading Terminals in Philadelphia or the North Station in Boston, as old as they are, still rank higher in the scale than many newer stations.

The prime necessities in any terminal are adequacy and convenience. One of the most important factors of convenience is accessibility. The position of the passenger station will be governed largely by topography, and by the relation that the position of the railway bears to the city and to the other lines. Freight yards and terminals should always be in a central location, for the nearer the facilities are to the business center the less time the trucks of the shippers will need to reach them.[1] Preferably, the passenger terminal also should be centrally located, especially if it handles a large commuter traffic, but the requirements are not so strict. A good location some distance out may often be fully as convenient as a far more valuable site directly in the heart of the city owing to the fact that the greater portion of the patrons probably have to ride to the terminal no matter where it may be placed. It is absolutely essential, however, that the station be as accessible as possible to all the trolley, elevated and subway systems and that if possible there be necessary the expenditure of but a single fare. If the number of commuters forms a large share of all the station's patrons, conditions are rather different and it is much more desirable that the terminal be near the office district and business center. The commuter does not like to pay an extra nickel to get to his work if he can avoid it because the extra nickel is too great a proportion of the total fare and counts up when spent day after day throughout the month. An extra 10 or 20 minutes on the trolley, elevated or subway each morning or night, looks large when added to only a 25- or 30-minute ride by train. The extra five cents or 10 minutes is but an infinitesimal portion of the total fare or time spent

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[1] This statement applies primarily to commercial yards with freight houses and team tracks and is treated in more detail on page 20 of "Freight Terminals and Trains."

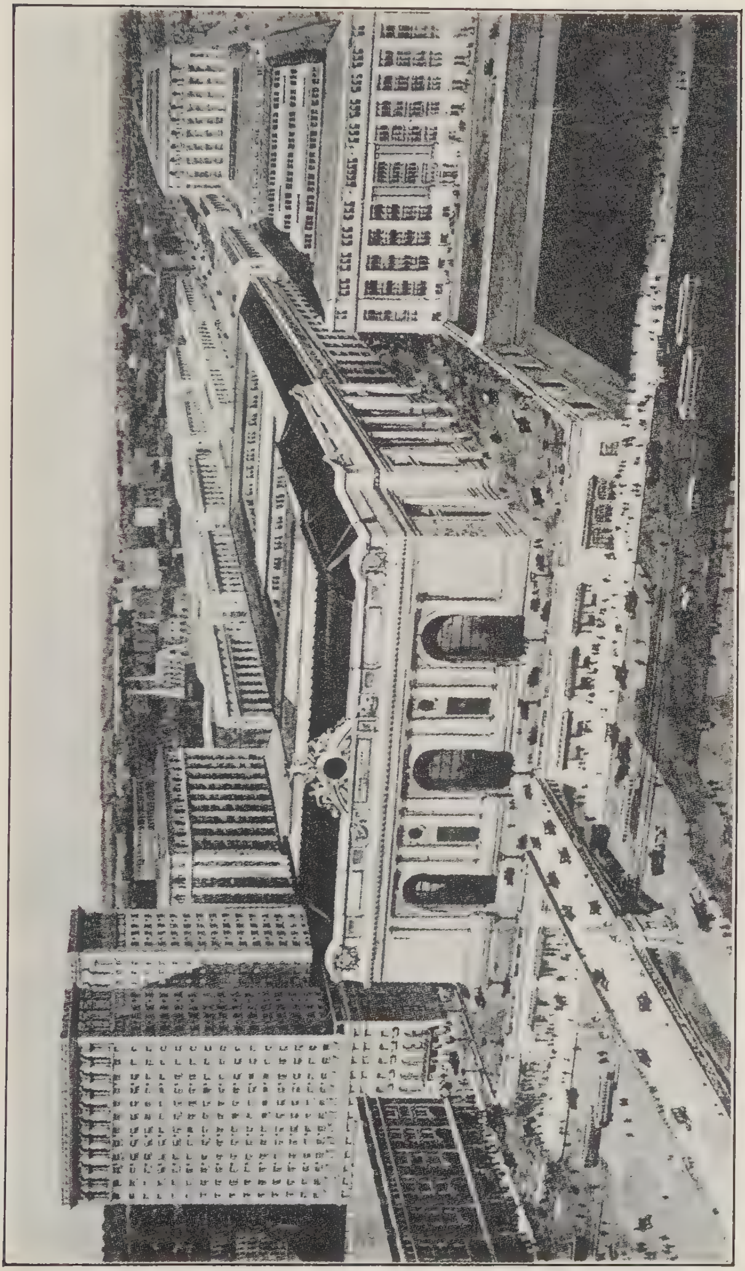

Fig. 10.—Bird's-eye view of Grand Central Terminal, showing office buildings on site of old yard.

on a long distance journey and probably will have to be spent by most of the travelers anyway.

If there are two or more terminals in a city it is, of course, best that they should be, if not near together, at least easily accessible the one to the other. The traveler cannot help but like that city best, other things being equal, in which he can go from one station to another with the least difficulty.

Another important element is competition. It is plain that if this is keen the more accessible and more centrally located station will get the business. Especially is this so if the competition is for suburban traffic. The commuter wants primarily convenience and regularity. If one line will take him five minutes nearer his work he will use it and forgive it for many little inconveniences for that alone. The point is clearer in the case of one station from which he can get to his work by walking as compared to a station from which he must ride, for, then, there is actually competition in rates, one road giving indirectly a cheaper fare. So is it with urban or interurban electric lines. The electric lines usually charge lower fares and generally strike further into the business district. If the commuter has to pay an extra five-cent fare or if he has to walk a much greater distance to reach the railroad station the electric line has a very good chance to secure the business, provided its service is at all comparable. If one of the important local considerations is competition, therefore, a central location only will be sufficiently accessible to get and hold the traffic.

It is not essential that the terminal be near the hotel district of the city which it serves. In almost every case, taxicabs, cars or private hotel busses will prove sufficient

There are some good ideas on the question of terminal location contained in the following paper read before the American Institute of Architects at Washington on December 16, 1909, by F. A. Delano, at that time president of the Wabash Railroad:

> Not only is the problem of terminal facilities for the railways in our large cities becoming very complex in itself, but it is evident that it cannot be disassociated from the problem of housing, of "intramural" transportation, or of laying out the cities' arteries, breathing spots, or their main centers of activity. All of these functions must be considered together and coördinated in order to get intelligent and satisfactory results. The extraordinary growth, in recent years, of cities in the Old World as well as in the new, has naturally been the cause of much wonder, comment and analysis.
>
> In the United States, at least, it has been found impossible for railways to plan for future needs more than 20 or 25 years in advance, under the most favorable circumstances, and in many cases projects for extensions and improvements that were thought, when planned, to provide for traffic so far ahead as to be extravagant have soon proved inadequate.

(A) **Geographical and Topographical Conditions.**—The general plan of cities is, obviously, chiefly controlled by geographical and topographical conditions; they may, for convenience, be divided into three typical groups:

1. New York (Manhattan Borough) is a type of city whose development and growth have been forced into certain hard and fast lines by the fact that it is built on a long and comparatively narrow strip of land between two great rivers.

2. Pittsburgh is an example of second type, being located on hills divided by deep and comparatively narrow river valleys. In such cases, of course, railway entrance to the city is almost necessarily forced into the valleys and the development must be adapted to the geographical as well as the topographical conditions.

3. Chicago, Detroit and Buffalo are good examples of a third type, in which the city has first developed along a large body of water and then grown in concentric circles back from the water; the topography is so nearly flat as neither to suggest nor to interfere with any particular plan. In the case of Chicago, the river presents some special problems and osbtacles to natural growth; but, generally speaking, this type of city develops on the plan of an opened fan.

(B) **Effect of the Height of Buildings.**—Although we hear much of the advisability of city ordinances limiting the height of buildings, the ordinances of one administration are likely to be disregarded or repealed by the next, and it may be said—speaking generally—that in this country we have not been successful in fixing any limit to the height of buildings; Boston is a notable exception. Many of our large office and store buildings accommodate 10,000 people; and it is said of a large retail store in Chicago, which occupies not quite an entire city block and has a height of only 12 stories, that it frequently happens that there are 25,000 people in this store at one time. If the so-called "Loop District" or business heart of Chicago were filled with 20-story buildings, a condition which seems to be fast approaching, we should have say 40 blocks, each accommodating 25,000 people. For that district alone, then, 1 mile long and ½ mile wide, our planning for streets and intramural transportation facilities must make provision for the daily incoming and outgoing of about 1,000,000 people, besides which an equal number will have to be cared for in the "fringe" or surrounding territory.

It is obvious that the magnitude of the problem is very great and that every transportation facility, underground, on the street level, and overhead, will soon be taxed to its utmost. . . .

(C) **Effect of the Housing Problem.**—It may be said, generally speaking, that the radius within which the worker in a city may live is determined almost wholly by the time it takes him to travel to and from his daily occupation, and the cost of the transportation. An overwhelming majority of the people must live within a half to three-quarters of an hour of their work and will not pay a fare exceeding 10 cents, morning and night. Hence, it follows that the quicker and more economical the transportation, the greater will be the radius of country open for the development of homes.

The healthy growth of our cities is, then, dependent on the concurrent growth of adequate transportation facilities, and the time is rapidly approaching when there will be practically no real homes within our big cities proper; there are apartments, flats and tenements a plenty—but no real homes, except in the surrounding fringe. In New York's east side there is a teeming population employed in and about their own tenements, but of the hundreds of thousands who daily go to and from their work in lower Manhattan, the business district proper, it is probably safe to assume that three out of four live outside of the island, while in Boston the percentage of workers in the city proper who live in the surrounding fringe is much larger, because of the greater adequacy of its suburban service.

In small cities, and in many of considerable size, it is desirable that the railway trains shall deposit their passengers close to the business center of the city; in most cities of the United States of under 100,000 inhabitants this is probably true. Even so, it is well to bear in mind that the city of 100,000 today which has its most valuable property occupied by passenger terminals will regret the adverse occupation of this land when it has doubled or quadrupled in size. In cities of the Old World, which were already great before the railways were created, and in our larger cities in this country, it is no longer possible and, to my mind, it is highly undesirable. The reason for this conclusion is that the railway terminal in a large city, if it be adequate to the needs, takes up directly and indirectly an immense amount of space, requires the closing of streets, and thus greatly interferes with the growth and development of a city. Indeed, a railway, both as an artery of traffic and as an obstacle, should be viewed like a great river or broad canal, for while it can be passed over and under more readily than a river, it necessarily forms a very important obstacle to any growth or development . . . .

Admitting, if you will, that the suburban passenger requires no elaborate terminal; that he would prefer a system of transportation which would give him an option of getting off at any one of several stations within the heart of the city—such service, for example, as the elevated roads or subways and surface lines give in our larger cities—the terminal for handling through traffic becomes the paramount consideration. The facts that people as a rule travel more than they used to, that long journeys are very common, that the comforts of travel require handling very long trains, that a modern passenger station must be supplied with many collateral conveniences, are all tending to increase the difficulties of the problem. An analysis of the travel will usually show that by far the greater proportion of the users of long distance trains are the well-to-do people who live in widely scattered districts, so that it is sometimes a mistake to assume that the passenger terminal must be central to the center of the population. A more correct statement would be that it should be near the center of convenience for the principal users. What the center of convenience is, is a matter of some difficulty to determine. To a large portion of the transient visitors, the conveniently located passenger station center would bear some relation to the natural or convenient hotel and theater center; to accommodate another large proportion of the traveling public it might be that it should be conveniently related to the residence districts, which are usually widely separated. But in no one of these cases is it to be expected or necessary that the passenger arriving by train from a long journey or departing on a long journey expects to do so without taking some conveyance. An analysis of the business will usually show that the large number of passengers arriving and departing on through trains use surface, elevated or subway cars, cabs, busses, automobiles, or other conveyances. The important question is not that it shall be within walking distance, but that it shall be conveniently related to these various means of intramural transportation. It has already been noted that every new facility of transportation, every quickening of speed, by annihilating distance increases the possible radius of distribution of the homes of the people whose whole career is directly connected with the city, even though they may not live within its corporate limits. Thus the automobile, though it is an expensive and perhaps extravagant means of transportation, is having a very influential effect in this direction. Indeed, one cannot study this problem without being impressed with the interdependence of through traffic terminals and intramural transportation facilities, and it is certainly true that if we settle the one without regard to the other we are adopting a short-sighted policy. The evils of this method are to be seen where it has been pursued. . . .

A complete study of the whole problem in every case will convince all that no final plan can be worked out which does not consider coördination of the city or intramural transportation facilities with the railway terminals. As has been well said, the railway station for through traffic has become the modern portal of a great city. Through it are passing the citizens of the city as they come and go on their journeys, and, what is perhaps almost as important, through it are passing visitors who frequently get their first and last impression of the city from this station and its immediate surroundings. Those of us who live in Chicago realize that much adverse criticism has come from those whose only impressions have been made by their journeys from the railway station to their hotels or business engagements; bad impressions which it has taken many favorable impressions to overcome. In some respects, the problem in Chicago is very difficult; in other respects, and especially when considering the number of units involved, it is remarkably simple. In more ways than one, however, it is just the same sort of problem that faces many other cities. It is a problem which cannot fail to appeal to the imagination of any man and is surely worthy of the deepest study of the best minds among architects, engineers and statesmen, as well as railway men.

CHAPTER II

CONSTRUCTION AND MAINTENANCE DETAILS

Next in order, but not in importance, to a station's accessibility is convenience in the arrangement of the terminal facilities and the proper relation of parts. This is a matter which is frequently subordinated to the necessities of architectural design, sometimes with reason, but more often because of lack of care or because the architects fail to realize that the terminal is not built primarily for a monument, but as a decidedly important railroad facility. It cannot be urged too emphatically, that it is all-important in every case to pay particular attention to the good and bad points in older terminals with a view to making the most of all experience that may be available. The various railway clubs and associations offer a splendid means among others of obtaining this experience in the safer way. In like manner, it is nothing less than foolhardy not to secure the suggestions and expressions of opinion of the operating officers who will be given the task of operating the new terminal or who may have operated similar terminals. These officers are in the best position to understand the needs of the patrons with whom they and their subordinates come in contact. They can best see those things which, if left unaltered, may cause costly inconvenience to the railroad and usually they can best determine whether anything is lacking. When the construction of a new terminal has been decided, a meeting or series of meetings should be called of the operating officers whose opinions will be of value. On the Pennsylvania Railroad in such cases, indeed, a regular committee is formed, consisting of representatives from the operating, engineering and other departments, an idea which could well be followed elsewhere. The various ideas should be thoroughly gone over and discussed as fully as possible. It is wise to remember that terminal building has not yet been nor ever will be reduced to a science as long as railroads and communities have an individuality worthy of the name. It is far better to settle these things in the beginning, for mistakes on paper are far more easily corrected than those in steel and granite.

There are certain facilities that of necessity must be incorporated in the important terminal. Included are a waiting room, baggage and express rooms, a parcel check room, ticket offices, retiring rooms and toilets. Provision is usually made also for telephone booths, a bootblack stand, a cigar, candy and news counter, a barber shop and various similar facilities, the number depending partly upon the demand for such facilities on the part of the station's patrons and partly upon the space available for them. For many years it has been the rule to include at least some space for offices. The amount is determined in large degree, of course, upon whether the terminal involved is at the road's headquarters or not. In the case of some of the larger terminals such as the Michigan Central Station in Detroit, the South Station in Boston or the Broad Street Terminal in Philadelphia the office room alone is equal to that provided in many large office buildings. In the case of the Grand Central Station in New York, in particular, there is to be a group of office buildings of such extent that the owners of the terminal expect almost enough revenue in rents to pay the fixed charges on the property.

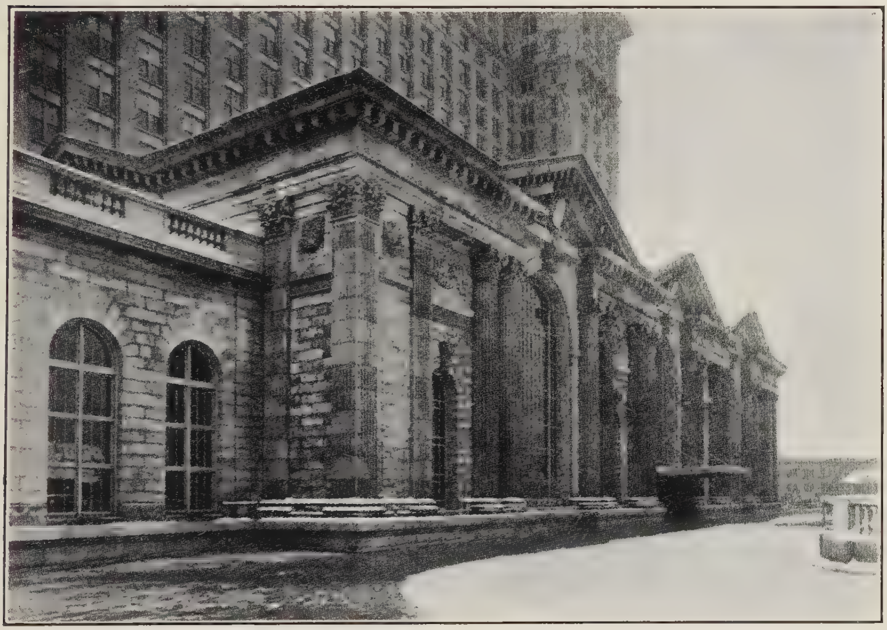

Fig. 11.—Michigan Central Station in Detroit, showing office building.

The two important things to be determined are: the correct location of each facility and the amount of space to be allowed it. The latter can be estimated only by a careful study of the amount and kind of travel, the proportion of through and suburban business, the peculiarities of the station's patrons and, in general, the needs of the community. Particular care must be taken to meet the needs of the future, it being remembered that the terminal will have to be sufficient for the growing traffic of at least 20 years. At many terminals also there are peak loads usually recurring at regular intervals. The well-designed station will be sufficient for these; the Union Station at Washington, for example, has facilities that are used to capacity but once in four years, at the president's inauguration.

The table herewith is of interest as indicating the relative size of the various facilities in a number of representative stations.

Dimensions of the Rooms of Some Large Stations[1]

	M. C. Detroit station	Penn. station, New York	Grand Central station, New York	Washington Union station	St. Louis Union station	Kansas City Union station	Boston South station	C. & N. W. station, Chicago
Main building, sq. ft.	91,770	339,270	202,573	132,526	48,480	140,030	52,480	69,760
Main waiting room, sq. ft.	22,932	33,000	17,156	26,280	10,068	26,100	14,625	25,000
Concourse, sq. ft.	15,912	131,400	....	98,800	36,360	24,290	54,900	17,000
Emigrants' waiting room, sq. ft.	....	....	....	....	3,590	2,000	....	14,285
Grand lobby, sq. ft.	....	*	81,122	*	8,940	22,060	....	21,900
Women's waiting room, sq. ft.	2,704	6,000	2,927	3,150	4,000	1,806	1,496	2,900
Women's toilet, sq. ft.	1,350	3,140	4,599	1,482	1,622	1,482	1,796	1,850
Smoking room, sq. ft.	1,500	6,000	3,779	1,998	3,930	1,978	2,146	1,200
Men's toilet, sq. ft.	2,033	3,600	4,516	1,743	1,198	3,498	1,525	1,450
Parcel room, sq. ft.	750	2,780	....	1,020	1,475	2,040	2,100	1,456
Baggage room, sq. ft.	....	50,000	....	41,683	42,000	74,648	27,794	66,650
Ticket office, windows	19	16	48	8	....	24	27	20
Restaurant, sq. ft.	4,056	6,900	10,090	8,000	4,920	3,891	4,356	4,000
Lunch room, sq. ft.	2,028	6,900	....	3,000	3,956	4,830	4,891	4,600
Schedule trains, daily	75	315	421	241	314	260	784	310
Passengers handled, daily	5,000	....	75,000	15,000	....	25,000	100,000	50,000

* Same as main waiting room.

In outward design the building should show clearly the main functions of the station, and the main waiting room or concourse, whichever is the more dominant feature, should be evident from the exterior. The proper entrances for patrons should be readily recognized and marked architecturally so that traffic will instinctively enter and depart from the building at the proper places and thus move in quickest and most direct manner. The carriage way and cab stands should be outside the street limits so as to avoid congestion. Not infrequently in modern designs sidewalk coverings are provided so that patrons may be protected in stormy weather when arriving at the station in vehicles.

It is axiomatic that in the well-arranged station the necessity for signs is small, for the various facilities are placed as nearly as possible in a natural sequence along the routes from the entrances of the station to the platforms and trains. In general, the layout should be such that there will be no obstruction to free and easy movements by the shortest possible lines between the streets and trains. The various facilities should be placed along these lines in a natural order so that the patron may be able to reach them without going out of his way or without retracing his steps unnecessarily. Where it can be done, the incoming traffic should be separated from the outgoing. Preferably, it should be made convenient for passengers to pass to and from trains without going through the waiting rooms. That is particularly the case where a large proportion of travel is suburban which has little or no need for waiting rooms, baggage rooms, ticket offices and similar facilities.

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[1] Compiled by O. H. Stone, Assistant Engineer of the Kansas City Terminal and published in the Railway Age Gazette of September 25, 1914 as part of an article entitled "Practical Considerations in Design of Large Stations."

> "The needs of through and suburban passengers are widely different. This, where both have to be handled, complicates terminal design. The simple, but imperative, requirements of the commuter, with the newspaper under one arm and package of garden seed under the other, is satisfied when he has an ample concourse through which he can race to a train, whose schedule he knows to a second. He buys a commutation ticket once or twice a month; he has no baggage to carry or check; and, if the railroad will furnish him the means of coming home to dinner on time comfortably, he will be pretty well pleased."[1]

The waiting room is one of the most important features of any passenger terminal. In many cases it is more or less of a great living room through which all the patrons must pass to reach their trains and about which all other rooms are placed. It is almost always provided with seats; or at any rate there are subsidiary rooms adjacent in which waiting persons may rest in comfort. The exact amount of such seating space depends largely upon the amount and kind of traffic. If suburban business predominates the waiting room can be small and, as noted above, preferably at one side. If through business predominates, the seating space per passenger must be large and particularly in important terminals where the trains are infrequent and waits are long.

That room which is almost always placed between the waiting room and the train platforms is usually known as the concourse. The value of this space is different in almost every layout. In some terminals, of which the Grand Central is the best example, it has been brought to a high state of usefulness and beauty and has most of the station's facilities grouped about it. In the usual station, however, it is of less importance either because it is dirty, or cold in winter or because the various other facilities are arranged about the waiting room instead. The latter arrangement appears to be the better liked and is, on the whole, the one most frequently followed. It has the one advantage, at least, that there is a concentration of activity with resulting convenience to the patron who is enabled to find with ease whatever he may desire.

It should be noted, nevertheless, that with the advance of terminal design there has been a strong tendency to improve the concourse. In many cases it has been entirely enclosed and so shut off from the train shed that the smoke and gases do not penetrate to it. In large stations where this has been done it is possible to centralize around the concourse those facilities related to traveling, and to locate the waiting room and its accessories at a point to one side of the direct route of travel through the station. The waiting room is thus made what it is intended to be—a place where patrons can wait with comfort, without having to mingle with the stream of travelers or to endure the drafts caused by the continual opening and shutting of doors leading to the street. Around the waiting room will be located the women's rest room, the men's smoking room and the dining room. The ticket office, baggage counter or room, parcel room, telephone and telegraph offices, and information bureau, will likely be located on the concourse.

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[1] From an article in the October, 1912, issue of *Scribner's Magazine* by Samuel O. Dunn, editor of the *Railway Age Gazette*.

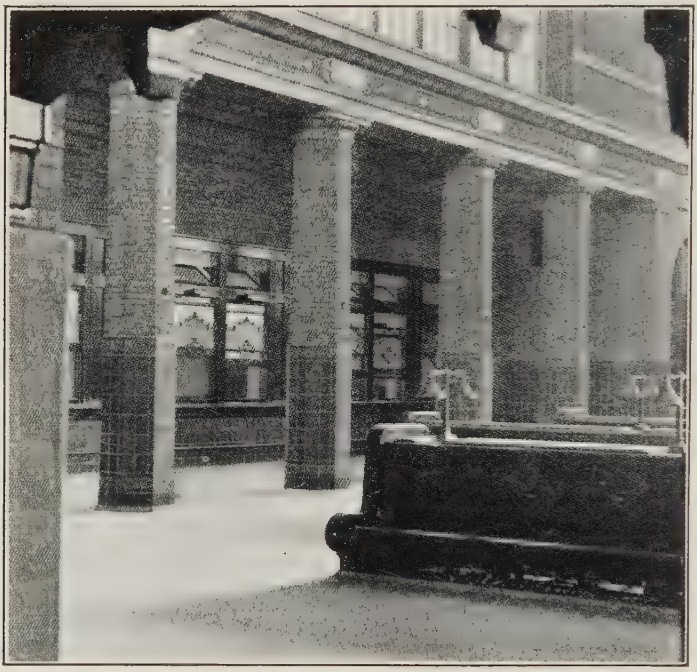

FIG. 12.—Corner of waiting room in New York Central Station at Rochester.

Many recently constructed stations have been built in connection with grade crossing eliminations. This often means a station with two levels, one at the street and one on the level of the tracks above or below. In such stations the waiting room is usually on one level and the concourse on the other. In the case, for example, of a through station whose tracks are to be elevated, the old station building can often be utilized and a subway or extension of the waiting room or concourse constructed out from the old building, passing under the tracks and connecting with the platforms by stairways. There are certain advantages, however, if they can be realized, of locating the waiting room at the track level. It will obviate the necessity for waiting patrons to pass up and down stairs if transferring from one train to another and under certain conditions it gives the over-anxious passenger an opportunity to discover when his or her train is ready, without having to run up or down stairs every few minutes to find out.

In some of the newer terminals the main waiting room has connected with it two units, for one of which the men's smoking room is the center, and the men's toilets, the barber shop and the boot-black stands its accessories; while the center of the other unit is the women's rest room, surrounded by the women's toilets, reclining and dressing rooms or, perhaps, a nursery. The old idea of dividing the waiting room into two parts, one for women and the other for men is becoming obsolete. In the southern states, however, it is usually necessary to provide separate facilities for colored persons. It is customary to make them similar to the facilities for whites, but less expensive and on a considerably smaller scale.

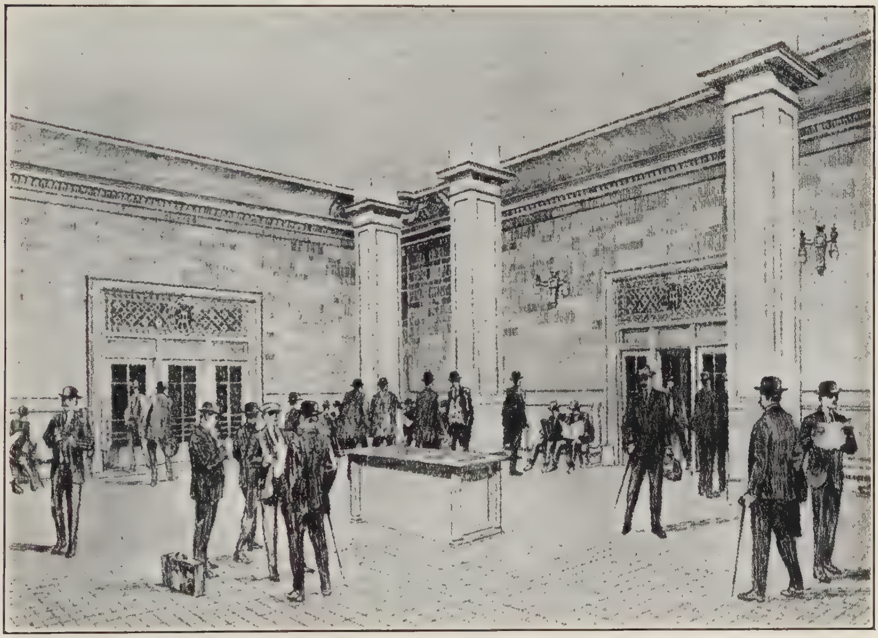

FIG. 13.—Men's smoking room in Grand Central Station.

The men's smoking room in the large station is usually provided with plain, durable furniture. It should be particularly well ventilated. In some terminals there are men's lounging rooms for men who do not smoke. Such rooms are usually plainly decorated and furnished with tables and easy chairs, much after the style of a club. In some cases even a library is provided.[1] The men's dressing room is a modern idea and is found in only a few stations.[2] It is for the accommodation of those men who, if they happen to be commuters and do not desire to return home to dress for an evening engagement, may do so at very little expense. It is also available to those men who arrive on long-distance trains and desire to change their linen before attending to business engagements. This room may be provided with a wash room, bath room and shower baths.

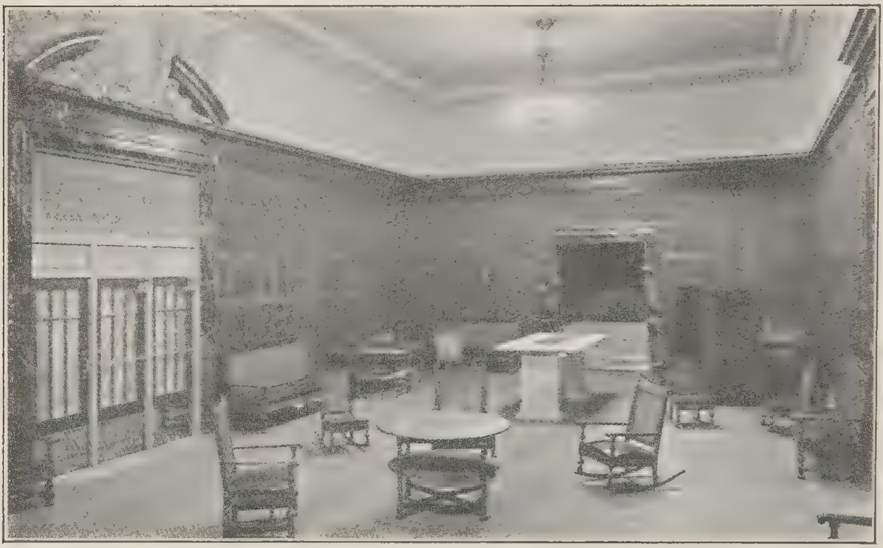

Fig. 14.—Women's waiting room in Grand Central Station.

The women's retiring room is usually decorated to conform with the rest room. Its furnishings should include easy chairs and lounges; and in some cases there are also cots available. A matron is usually in attendance.

Water-closets in railway stations are subject to much abuse, more because of the varied character of the persons using them, rather than their numbers. Automatically flushing closets and urinals are desirable. The plumbing should be of the best but preferably without brass or other valuable parts readily removed and stolen. In the Grand Central Station in New York, excellent results were economically obtained by the use of a composition material for toilet seats made by one of the manufacturers of billiard tables and supplies. Slate, glazed tile, marble or granite are the best materials for walls. Asphalt, slate, granolithic or other hard substance should be used for flooring because such materials withstand wear and are readily cleaned. A few pay-closets should be provided in both the men's and women's rooms, where, for a small charge, soap, towels, brushes, combs and mirrors may be obtained.

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[1] As, for example, in the new Michigan Central Station in Detroit.

[2] Including the Detroit Station and the North Western Terminal in Chicago.

Ticket offices, whether on the concourse or in the waiting room, should be so placed that their windows and the signs over them are in full view of the intending ticket purchaser. The windows should also be located relatively to the baggage room as nearly possible in such a position that the passenger who has purchased his ticket can proceed to the checking counter without leaving the line following the general direction toward his train. It is even more essential that they should not be in such a position that the lines in front of them awaiting tickets will congest or obstruct the general thoroughfares. Failure to give due heed to that essential of design, seemingly unimportant, has been a serious disadvantage in more than one important station. The windows, accordingly, should be on the opposite side of the room from the train platforms, or at least so placed that the patrons will at once leave the office after having purchased their tickets. It has been found by experience that the passengers are very likely to become nervous when at the windows if there is not a large clock in sight.

FIG. 15.—Women's waiting room, North Western Terminal.

The information bureau should be located in the most central position possible in the concourse or lobby in plain view of incoming and outgoing passengers. It should be equipped with time-table racks sufficient in size to contain all the latest time-tables which may be in demand. The men in charge must be able to give information courteously, concisely and accurately. In most cases there are telephones for giving information in answer to outside calls, although sometimes a separate bureau located in an out-of-the-way part of the building, handles the telephone calls exclusively.

In the earlier stations the baggage room was located so as to be as near the tracks as possible and still be convenient for the passengers to check and identify baggage. One baggage room was sufficient for both outgoing and incoming business. In the larger stations two baggage rooms are now required, an outgoing and an incoming room, usually located on opposite sides of the station. This arrangement requires the passenger to walk a considerable distance and to lose valuable time. In many of the more modern terminals, therefore, where the baggage rooms are at a considerable distance from the concourse, auxiliary baggage check rooms have been established near that facility or the waiting room for the receipt of suit cases or other parcels. Where this arrangement is used, valuable space is made available for other purposes and at the same time the baggage rooms may be located where they admit of the most rapid handling of baggage to and from the trains.

In larger stations there should be ample and convenient storage room in which undelivered baggage may be placed for better keeping and to prevent the working rooms from becoming congested. Of course, if these storage rooms are on a different floor, convenient elevator service should be provided.

Dining rooms and lunch counters in railroad stations have been demonstrated to be useless unless they are located where passengers can readily see them as they go to or from their trains and unless they are adjacent to the point where passengers board outgoing trains—preferably in sight of such trains. In this the nervous American passenger exhibits a characteristic alluded to elsewhere in connection with having a clock in sight while he waits to purchase his ticket. He will eat longer and more contentedly if he can see for himself that he is not going to be left behind—and he hesitates to depend on announcers or bells. The outgoing passenger will be more likely to patronize the dining rooms and, in fact, all similar conveniences than the incoming patron. These facilities should be placed, therefore, with this in view. In the large through station at Providence, R. I. (Chapter IV), an elaborately planned dining room and lunch counter proved a financial Waterloo to the tenants and owners because it was a little to one side of the usual line of travel. Its use for this purpose had to be abandoned. A simple lunch counter arranged in one of the main waiting rooms in full view of waiting passengers and those going to and from trains proved remunerative to owners and lessees, although so cramped for space that the kitchen had to be located over the main entrance in a part of the clock tower, an arrangement incidentally, which proved particularly efficacious in doing away absolutely with all the odors of cooking.

Precisely the same qualification applies as concerns the other concessions. If the proper course be followed, a large revenue can be derived from the renting of extra space. In many stations, especially the new ones, there are well-arranged arcades of stores selling everything that can be of possible use to the long-distance traveler or the commuter. It is absolutely essential that these spaces or arcades be directly in the lines of travel. If they are not, the stores will lack patrons and the efforts to utilize the space will be futile.

Such facilities as the telephone and telegraph offices should be located conveniently to the main traffic routes through the station. There is little waste space in a well-designed and well-operated station. Rentable space is carefully considered and it is very seldom in well-operated passenger stations that any space can be found which is not utilized for some commercial purpose. This space is generally rented for tobacco stands, news stands, apothecary stores and furnishing stores, which often bring in good financial returns for the proprietors, as well as suitable returns to the railroad in the form of rentals.

A careful study of the arrangement of the racks in the parcel room will aid much in increasing the capacity and thus increasing the income from this facility.

A hospital room with all necessary equipment, and a doctor and nurse in attendance or on call, is becoming a requirement in the design of large stations. It should be in as quiet a place as possible.

One of the latest terminals[1] has incorporated in its design a separate waiting room where persons may meet incoming passengers, thus preventing the waiting crowd from interfering with the general flow of traffic through the station. This terminal also provides a room for detention of prisoners or suspected persons and is used as headquarters for the city police officers, having direct connection with general police headquarters. In some stations[2] special waiting rooms are provided for funeral parties and for important personages who are required to wait in the station. Show rooms for salesmen are sometimes provided, with the necessary tables and other equipment used for the exhibition of goods.

A facility which has become a necessity in large stations is a waiting room for immigrants. It should be in an out of the way place, and may even be in a separate building. It should be furnished with complete sanitary equipment, and, if possible, tubs for washing clothes and dryers. A lunch room for immigrants where food can be served at a low price is desirable. Immigrant rooms should be well ventilated and the interior of them so designed that they may be easily cleaned.

[1] The Pennsylvania Station in New York.

[2] The Union Station, Washington, has such rooms.

In older terminals the heating was accomplished by radiators located mostly in the middle of the waiting room. In the modern station hot air is blown up through radiators located at the backs of seats, if located along the walls, or from between the seats which set back to back. In the recently rebuilt station of the New Haven at Hartford, Conn., the radiators are entirely covered and concealed by settees. In the largest stations the hot water system of heating is used, both indirect and direct methods.

Stations should be designed so as to give very little place for dirt and dust to lodge. To meet this requirement the floors, ceilings and walls are often made of stone, brick, or glazed tile, and sanitary bases are installed, the seats being the only wood present.

It seems superfluous to say anything regarding the absolute necessity for fireproof construction. The railroad terminal, as compared with most other structures, offers peculiarly good opportunities to the careless or intentional incendiary, open as it is at all times of the day or night and often some of the time without adequate supervision. There is an even more important reason for fireproof construction, in that if the station is destroyed the railroad can do business, if at all, only under the greatest handicap. The reader is referred to the place in Chapter III where is recited the experience of the officers of the North Station in Boston when interlocking Tower A was completely gutted by fire. It will be borne in mind, moreover, that the interlocking tower is but part of a station and not the whole. To avoid interference with traffic through fire destruction rental of space for garage or automobile repair purposes, or to any concern using or storing inflammables, should be very carefully considered and, when done, surrounded with all necessary precautions to prevent fire.

Since the earlier stations were on one floor and on the same elevation with the tracks, the problem of stairways, elevators or ramps for handling large crowds was not considered. But as the train traffic increased and as grade crossings in cities were eliminated, leaving the tracks at a different grade from that of the streets, the problem of stairways became an important one.

Stairs as broad as possible, with risers of about 6½ in. and treads about 11 in. wide and with landings every 10th to 15th stair, are considered the safest and admit of fairly rapid travel. Elevators are a comfort and convenience to passengers, but the majority of the patrons, not liking to wait for the elevators if the latter are not at the landing, find them too slow. At Back Bay Station in Boston, for example, there are large elevators available for use between the platform and the street, one level above, but only a small proportion of all the passengers make use of them. Elevators, moreover, require large operating costs and are a source of danger. They can, however, be located in a small area.

Ramps have been found very valuable for moving large crowds from one elevation to another in modern stations. The chief objection to them is that a great deal of room is required, but there is no doubt that they handle crowds much more quickly and safely than either stairs or elevators.

The movement of persons up and down stairs was most carefully studied by the designers of the Hudson Terminal in New York, and later by the designers of the Grand Central Terminal in the same city. Some of the results of the former investigation were explained by Messrs. Davies and Wells before the American Institute of Architects, December 16, 1909. In the study a count was made of the actual movement of traffic at congested points in New York City, as for example, at Brooklyn Bridge. It was found that in a straight passage of ample width the crowd, in the rush hours, moved at a speed of 300 ft. per minute, walking with a step averaging 2½ ft. There is only a small reduction in this speed on ramps with a grade not greater than 10 per cent. Thus each person, on the average, occupies about 10 sq. ft. of space, and the movement discharges about 30 persons per foot of width of passage. This number is about the same if the passageway becomes congested and the space occupied per person reduced, but the speed of movement is also reduced. Any contrary movement in a broad passage reduces the movement rather more than the relative space occupied, but in narrow passages the relative reduction is much greater notwithstanding the fact that persons crowd into smaller space. It was also found that a crowd moving freely upstairs takes about the same number of steps per minute, approximately 120, but that it advances only about 12 in. each step instead of 30 in. Upstairs movement is much more dense than downstairs but correspondingly slow. For each foot of width 20 persons moving upward may be discharged per minute as compared with 18 moving downward. There is not much difference in the discharging rate on stairs over 4 ft. wide, if the movement is all in one direction. It was found, however, that movement on stairs of all widths, particularly those less than 8 ft. wide, is seriously impeded by any contrary movement, even when but four or five persons a minute were moving in the reverse direction. An actual count indicated that generally, for all stairs more than 4 ft. in width with all the movement in one direction, for an upward movement a maximum of 20 persons could be discharged per foot of width of stairs per minute, and for downward movement 18. The average for ordinary free moving crowds was 15 and 13 per minute, respectively. The investigation also showed that if there is any contrary movement it is of great importance that persons should be forced to the right-hand direction and that generally speaking no stairs serving traffic in contrary directions for railroad service should be less than 5 ft. clear width.

Lighting a station room, in common with other public rooms, is a problem in itself which is being given most careful study, and to which specialists are giving their attention.

The color of light depends upon the length of the waves set up by its source. The light waves which produce the colors at the blue end of the spectrum are very short as compared with those that produce the colors at the opposite end. The source of red light gives off only waves of the length which produce that particular color. Objects, on the other hand, are made visible by the light reflected from them. A body appears red because its surface is capable of reflecting only waves of length corresponding to red. A blue body cannot be illuminated by a red source, for the former is able to reflect only those short waves producing blue; the red source contains none of these. There will, therefore, be no reflecting and the body will appear black.

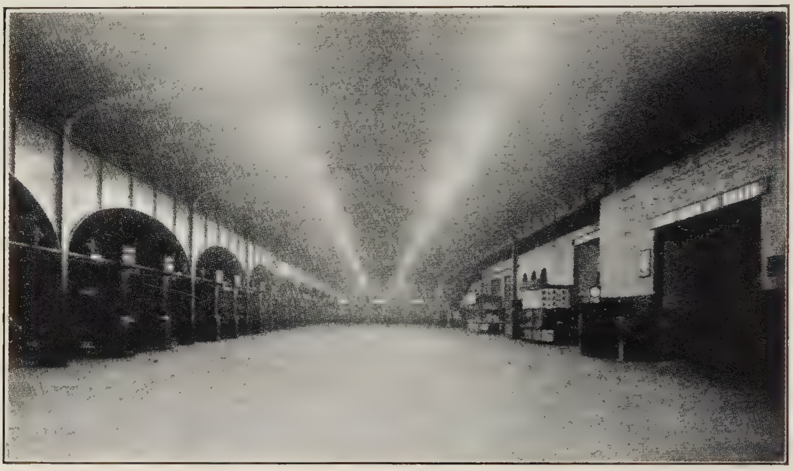

FIG. 16.—Concourse of Central New Jersey Station, Jersey City, showing illumination at night.

This property of reflection, or rather of absorbing light, is most important. An illuminant is powerless to light a room if the color of the walls absorb most of the light rays. It is estimated that a white wall will reflect 50 per cent. of the light directed upon it. A light buff or yellow reflects 45 per cent., a light apple green 40 per cent. On the other hand, red or dark green will reflect but 15 and dark brown but 2½ per cent. In like fashion dark wood trimmings absorb and white trimmings reflect light. Velvet, chintzes and burlap also absorb, while tinted surface walls reflect. Thus it follows that rooms facing north and east require lighter walls and trimmings than do rooms facing south or west.

Ideal illumination reflects just enough light from the object to the eye so that it can be seen easily and clearly. Too much light is objectionable; the iris or shutter of the eye can contract and shade the eye only a limited amount, and soon tires and weakens, when the iris expands, allowing the strong light to enter the eye. A strong light striking full on the retina of the eye is very detrimental. Flickering lights are likewise hard on the eyes, as the iris has to be continually readjusting itself to streaks of different intensity.

It is axiomatic that light should approach as nearly as possible the exact color of sunlight. The lighting specialists are securing their best results in interior and artificial illumination by the aid of indirect lighting. With the latter all the light is thrown to the ceiling and walls and thence reflected to the lower portions of the area to be lighted, giving a soft mellow light, with no sharp points to blind the eyes. With direct lighting only, opaque shades placed directly above the lamps reflect all the light downward. This is the more common and cheaper method, but the light is not distributed evenly, there are heavy shadows and the bright points of light are left free to shine directly into the eyes. Diffusing shades and ground glass are often used, however.

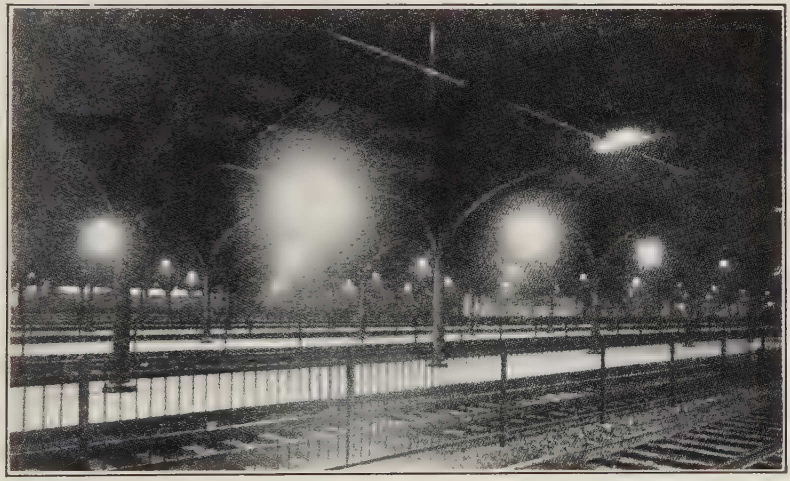

Fig. 17.—Train shed of Jersey Central Station, showing artificial lighting.

The lighting of station platforms, particularly as it relates to safety, demands more attention than interior lighting, although there is less criticism invited if it is improperly done. As with interior lighting, care must be taken to have the light well diffused and to avoid shadows. Unequal light distribution—that is, striking contrasts of light and dark—is often no less dangerous than insufficient lighting. The oil lamp is now confined in great degree to small outlying stations where gas or electricity is not available. Where oil is used, lamps of the Dietz type with a large flame and reflector are usually found satisfactory. When gas is the illuminant, the mantle light will give the better light and be more economical than others. If electricity is used the arrangement, kind and number of lamps requires careful, intelligent and thorough study. There are practically no passenger stations where full all-night lighting is necessary. In most cases, as well, less lighting will suffice between trains. For economy's sake, therefore, there should be an ample number of conveniently located switches.[1] At the small station the lights can best be turned on and off from a switch in the ticket office. In the larger station, however, switches should be so arranged that the platform or gate men who have to regulate the lighting for a particular track or portion of the station can have an easy access to them. It has been found advisable in many cases to have all necessary lights on just before a train arrives or leaves but to turn off one-half or two-thirds of them as soon as it has gone. Much unnecessary current may be consumed because of awkwardly located switches or imagined economies in wiring making necessary the use of lights at times when they are not needed. As far as platforms or stairs are concerned it does not matter whether the lighting be direct or indirect. The latter is usually the less effective because of the lack of light surface to give sufficient reflection. At any rate, for safety's sake if nothing more, platforms and stairs should be adequately lighted. In the case of the latter, in particular, the first and last step should be especially clear. On the other hand, a bright glare up and down the track in the eye of an engineman, or rays tending to obscure signal lights, must not be permitted.

In older stations the platforms were built at the height of the top of the rail. The modern custom of constructing them about 10 in. above the rail makes the operation of boarding and alighting from trains much more rapid; and the even more modern method of constructing station platforms at the grade of the car floors and equipping the cars with lift decks still further adds to the rapidity and safety with which the passengers can be handled. Furthermore, this latter design allows an accessible space under the platforms adequate for piping of all kinds.

Ample and conveniently arranged platforms, especially if they be covered and provided with comfortable benches, will often serve as adjuncts to the waiting rooms and in many cases may even perform much of the work for which the latter are required. In summer, in particular, passengers prefer the outside; and that becomes an important factor especially at suburban stations or pleasure resorts because in some cases it obviates the necessity for a larger building or waiting room. Longitudinal platforms usually range in height from 2 to 16 in. above the top of the rail. The outside edge should be from 4 to 5½ ft. from the center of the track. Platforms should never be less than 12 ft. wide.

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[1] In the new (1915) Hartford, Conn., station of the New Haven each of the larger lights attached to ceiling, in the main waiting room, is controlled by an independent switch. The same is true of each light in the main office rooms.

They should always be wide enough to accommodate the passengers and, also, of such width that moving trucks may pass other standing trucks without serious inconvenience. Cases are frequent where island platforms are wide enough to allow for a waiting room, well heated and lighted, between the tracks.

Where there are posts on the platforms greater width is desirable, 20 to 24 ft. being none too much. It is probably better to allow 28 ft. from center to center of the tracks if there are such posts—and not less than 24 ft. if there are none. Supporting posts for sheds or awnings should not be less than 7 ft. 6 in. from the nearest rail. It is wise in the case of stations on single-track lines to anticipate double tracking, and on double-track lines to anticipate third or fourth tracking. Hence all permanent structures should be located so as to admit of such improvements without extensive changes and the platforms in front of them should preferably be no less than 24 ft. wide so that, if another track is put in, a reasonably wide space will still be left for the platform. The same idea would lead one to suggest that all new stations be placed on one side of the line as far as that is possible.

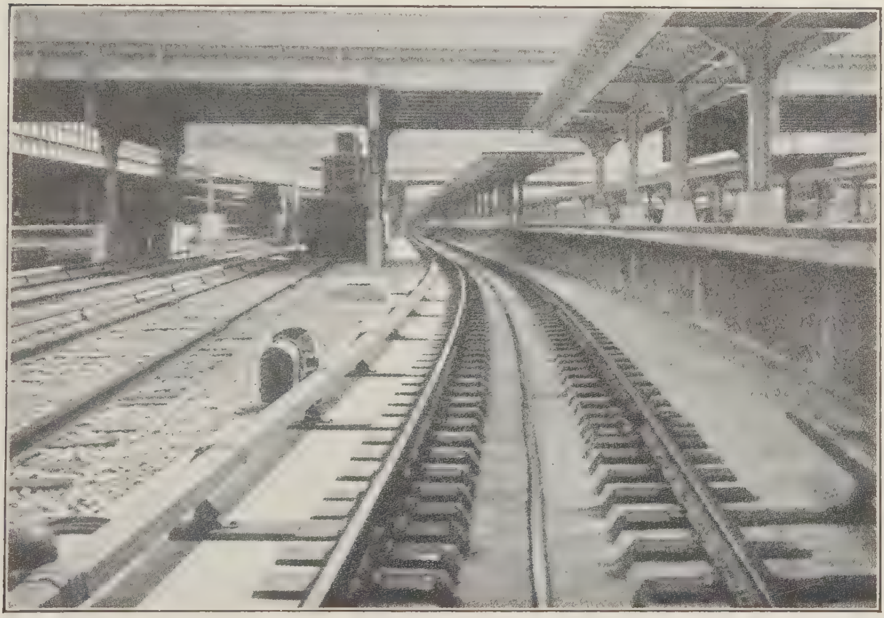

FIG. 18.—View in Grand Central Station, showing track construction, raised platform and train sheds.

The insufficient width of the platform on one side of the recently completed passenger station at Worcester, Mass., should be studied as something to avoid. That there is not sufficient width to enable an average express or baggage truck to be moved between the stairway exits and a train on an adjacent track is one of the unsatisfactory features and one showing the necessity for combined engineering and operating experience to get the best results in designing important and expensive terminals.

There is always some danger that persons may stand too near the track no matter what the width of the platform behind them may be. Baggage trucks, besides, which are being wheeled back and forth, or those not yet removed, may be too near passing trains for safety. These considerations, far more important when the platforms are narrow, have led some roads to introduce the so-called "dead line" for their station platforms. The St. Louis & San Francisco, in 1912, had a broad white line painted the full length of every platform, parallel to the track, 5 ft. from the edge and 7 ft. from the nearest rail. The general manager then issued an order that no truck should be allowed outside this line when a train was in motion. All trucks had to be moved inside of it after the train had stopped and outside of it again before it had started. There was no rule applying to passengers. It was found, however, that a large majority caught the significance of the white line and remained on the safe side of it, even on crowded platforms.

The Chicago, Rock Island & Pacific at one time applied a similar idea at its Englewood station, Chicago. In this case the efforts were directed toward the passengers rather than toward trucks. The platform at the station is located at the end of a curve, and the risk of being struck by a train was therefore greater. A white line, 7 in. wide, was painted on the brick platform, 6 ft. from the nearest rail, and prominent signs were displayed reading: "Danger—keep back of line—watch your children." The signs, painted in large red letters on a white background, were hung from the under-side of the roof of the umbrella shed at intervals along the platform. Other roads, such as the New Haven and the New York Central, have since used the so-called "danger line"—using red on cement, or other light-colored platforms—white on wooden or dark material—with the words "Warning—Keep Back," or "Danger—Keep Back." It is possible to install these dead lines in white tile, brick on other material, depending upon the character of the platform, and to eliminate thereby the greater portion of the maintenance cost.

There are several materials satisfactorily used in station platforms. Of them, tar-concrete is comparatively inexpensive but requires some care to keep in repair. Granolithic pavement wears smooth and sometimes becomes very slippery. Brick is liable to break and get out of place when trucking is done over it. The pitch of a platform should be between 1 in 48 and 1 in 24, the former being the slightest incline from which water will run off freely.

In the older stations and in some of the smaller modern ones the baggage is carried from the baggage room on trucks through the midway and down the passenger platform, all of which causes great annoyance and inconvenience to passengers. To avoid this difficulty modern designs call for the installation of subways at each end of the passenger platform and connected with the passenger platform by means of baggage elevators. This requires that the passenger platforms shall be used only through a portion of their length by the baggage trucks. Another and a better system, where room is available, is to locate an additional platform for the exclusive use of baggage trucks between each pair of coach tracks.

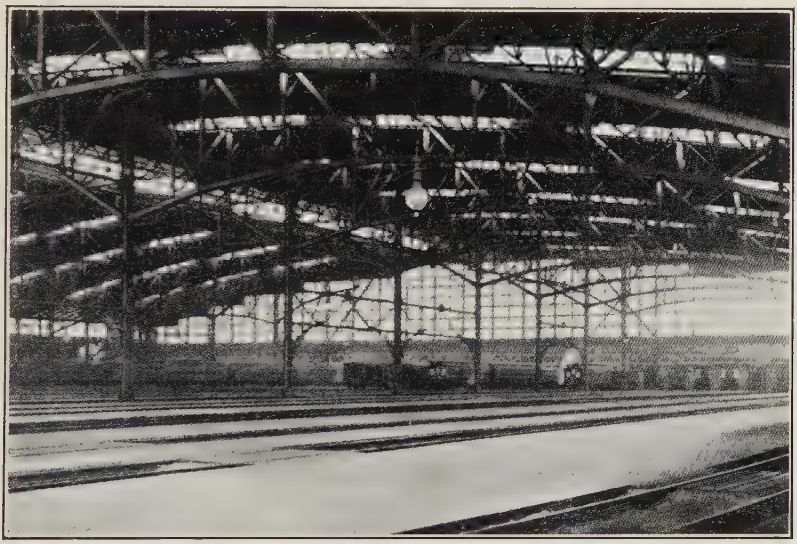

Fig. 19.—Massive train shed of South Station, Boston.

When an old station at street level is remodeled as a part of a track-elevation project, one of the most difficult features is the design of the baggage-handling facilities. Sometimes use is made of a baggage subway from which elevators run to the elevated platform level. Another method is to raise all baggage by elevator in the baggage room and truck it across the tracks from platform to platform. This latter method is impossible if the platforms are much higher than the tops of the rails. The higher the platforms above the rails, however, the quicker can the passenger traffic be handled, and it is sometimes possible to put an incline in the platform near its ends and bring those portions of it down practically to top of rail level and in that way provide places where the baggage can be readily trucked across the tracks. A modification which saves baggage elevators altogether is to locate the baggage room at the track level and arrange its driveway approaches so that all baggage and express can be delivered at the level of the elevated platform. This is sometimes done by closing an existing street at the railroad location line and cutting through another in substitution therefor.

The day of the great awkward arched train shed is long since gone. There was a time when in railroad terminal architecture it was considered as the most necessary adjunct (or evil). It will long remain a problem to the average person that these sheds had such wide popularity and that so little use was made of the cheaper, cleaner, or, in fact, better umbrella sheds. Some of the great arched sheds were really remarkable, nevertheless, there being cases, for example, where an arch of single span covered from 25 to 32 tracks. The train shed over the tracks of the South station in Boston built even as late as 1898 covers 28. In view of the widespread use of the old style train sheds it is pleasing to our present sense of vanity to be reminded how expensive they were to build and how costly to maintain. It was, or is, where they still remain, necessary to paint the steel work almost continually to protect it from the smoke and gases. The great area of glass and copper cost quite enough when new and repair costs have never ceased. And what is worse, the sheds are dark and dirty, the coldest places in town on cold

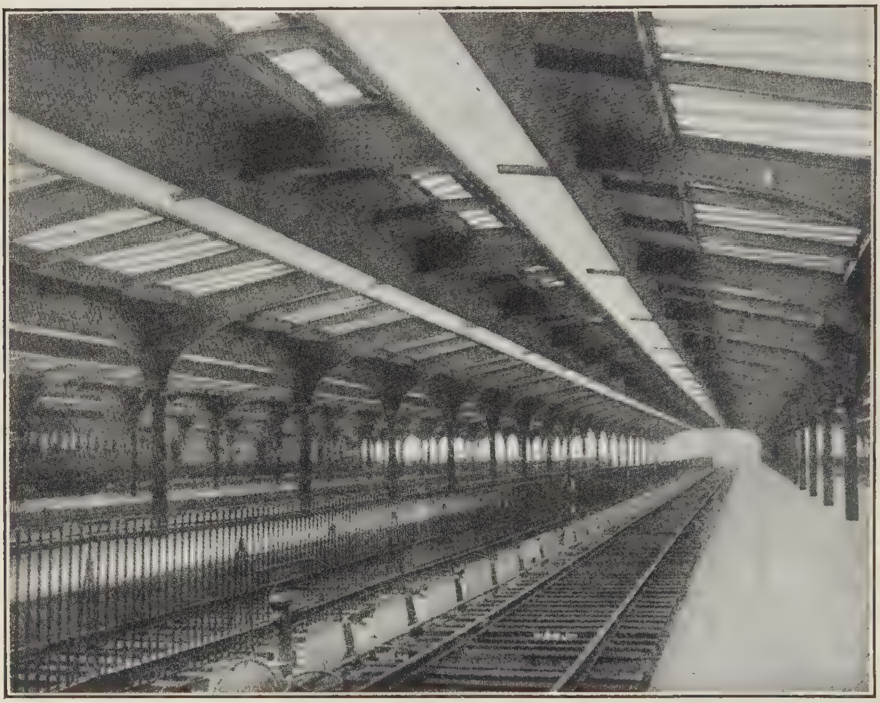

Fig. 20.—Bush train shed at Hoboken—the first of its kind.

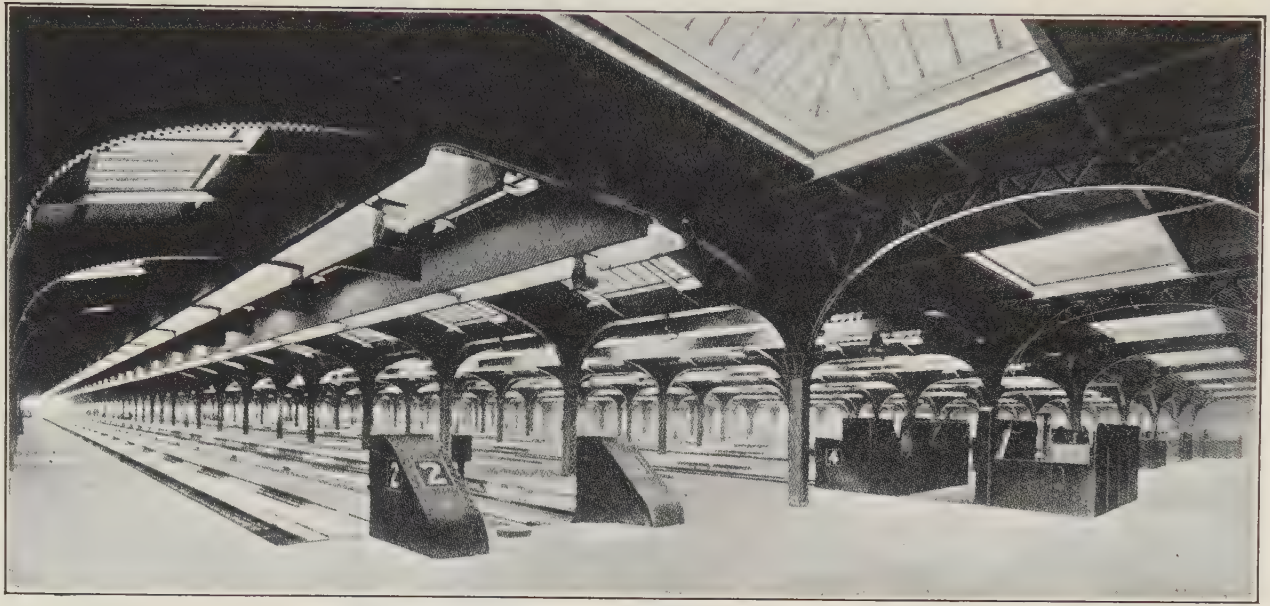

FIG. 21.—Train shed in North Western Terminal.

days, the stuffiest on hot. They are rarely if ever adequately lighted and in the minds of many it is doubtful if they ever can be, since all the smoke and cinders instead of being carried off into the air settle and darken all the surfaces of whatever kind. Things are at their worst on foggy days. It would be bad enough if this were all. The dirty shed, however, is contagious; and concourse, waiting room and all the rest are apt to be in keeping with it.

In the last few years greater use has been made of three types of sheds that have practically all the advantages of the old arched shed and none of its disadvantages. These are the umbrella, the butterfly and the Bush. The first two names are self explanatory.

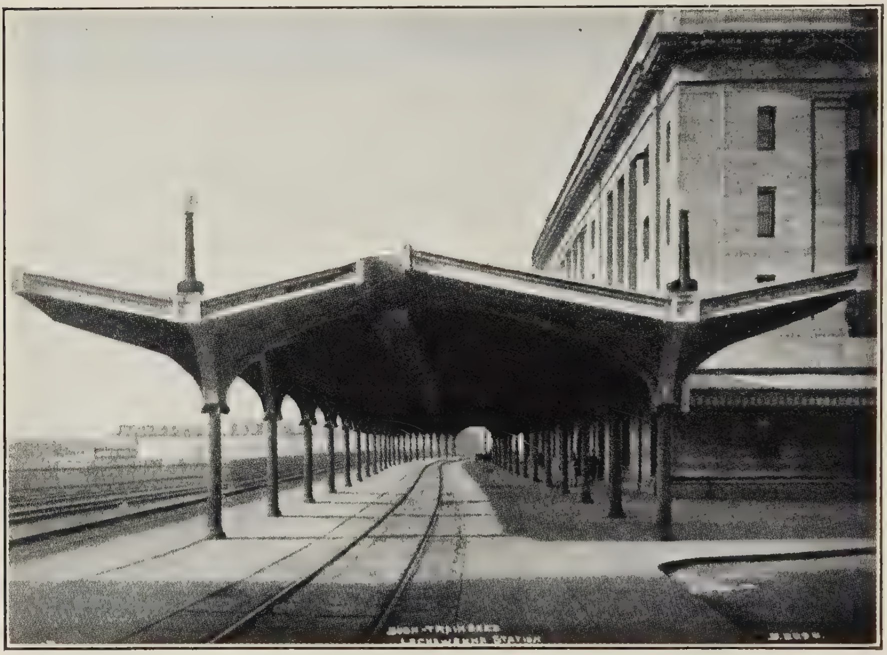

Fig. 22.—Bush shed at Scranton.

The Bush train shed is the invention of Lincoln Bush. The first installation of a shed of this type was in 1905 when the Delaware, Lackawanna & Western, of which Mr. Bush was chief engineer, built its Hoboken Terminal. A view of this shed is shown in Fig. 20. It differs essentially from the umbrella or butterfly sheds in that it is continuous except merely for the slot or gutter through which the locomotive smoke and steam are discharged. With the Bush shed, and to a slightly lesser extent with either of the other two sheds, there is almost absolute protection from the weather, on the one hand, and at the same time the space beneath the shed is entirely free from smoke and dirt, and exceedingly well ventilated. The sheds cost but half as much as the large arched sheds and are far cheaper to maintain.

The Lackawanna's Hoboken shed consists of a number of longitudinal sections built of constructural steel, reinforced concrete and wire glass. In all cases where the steel would be subjected to the locomotive gases it is protected by concrete or copper. The roof is supported by longitudinal rows of columns, 27 ft. between centers, and the maximum height of the roof spans is about 16½ ft. from the top of the rail. Transverse built-up girders are placed between the columns and resting on these are longitudinal purlins which support directly the reinforced concrete roof slab and the skylights in it. The longitudinal opening over the locomotive stacks extends the length of the train shed and with the exception of the roof-girders it is entirely open. The tops of the locomotive stacks come within 6 or 8 in. of this opening and practically all of the exhaust is discharged through it into the open air. The girders and purlins directly over the smoke stack are encased in concrete to protect them from gases. To protect the platform from rain and snow and to direct the gases, a built-up section encased in a concrete slab reinforced with wire mesh, 4 in. thick by 2 ft. 1 in. high, is placed on edge on either side.

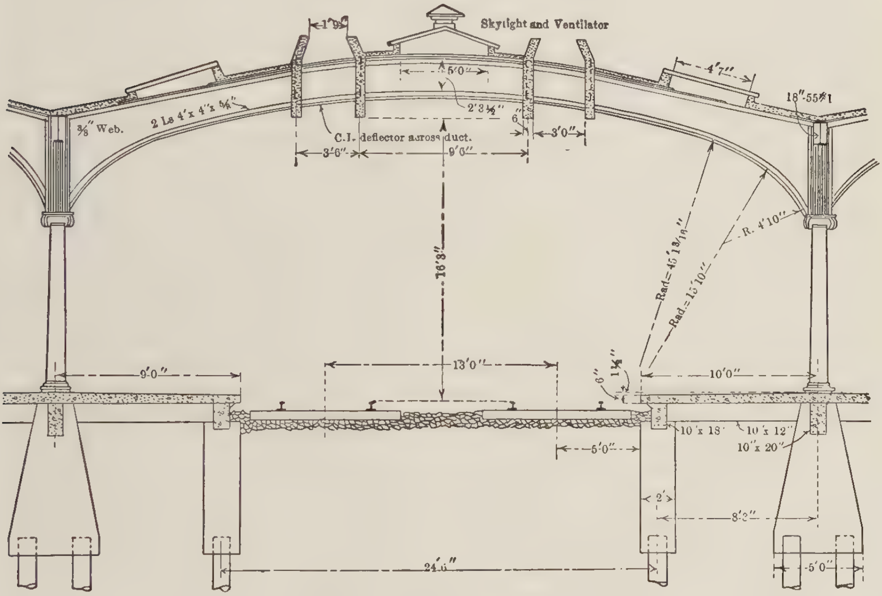

Fig. 23.—Details of Bush train shed in Central of New Jersey Station.

There are three continuous sidelights, of wire glass, each 6 ft. wide, placed longitudinally in the roof of each section. The one in the middle of the section and at the peak of the roof admits light directly to the inside windows of the cars and the remaining two rows of lights over the platforms admit light to the outside windows. In addition to the transverse pitch which is given to the roof in both directions from the center, it also has a slight longitudinal pitch between the columns. A copper gutter, running longitudinally, is placed over each row of columns. This is connected with a down spout in each of the hollow vertical cast-iron columns.

Many other Bush sheds have since been constructed as can be seen from the list herewith. That of the Central of New Jersey station in Jersey City, one of the most recent, incorporates certain improvements. The train shed is made almost entirely of concrete. The smoke duct is tapered at the top in order to give better protection from the weather and at the same time to present a bottom opening wide enough to catch most of the locomotive gases. The width at the bottom is 3 ft., and the minimum width at the top is 1 ft. 9 in. The skylights have been made smaller than those used in earlier designs in order to reduce the amount of breakage, which in some cases has proven an expensive item of maintenance. The two side lights in each span are 4 ft. 8 in. wide, and the ridge light is 5 ft. wide. All of these are 24 ft. long. Rolled steel bars, sealed with lead, support the ¼-in. rough wire-glass. All exposed metal parts, including bolts, nuts, rivets, flashing and ventilating ridge, are of Monel metal. All skylights are raised on concrete curbs to keep out water and snow. A 3-in. water shed is provided in all gutters from the center of each panel toward both ends. The drainage is carried down the inside of the columns to drains which lead to a 24-in. outfall main. The upper ends of the downspouts are closed by cast-iron strainers.

List of Bush Train Sheds in Use on January 1, 1915

Name of railroad	Location	No. of tracks	Area, sq. ft.	Area, acres	Remarks
Delaware, Lackawanna & Western	Hoboken, N. J.	14	208,785	4.79	Completed 1906.
Delaware, Lackawanna & Western	Scranton, Pa.	4	37,026	0.85	Completed 1908.
Western Pac. Ry.	Oakland, Cal.	4	44,400	1.02	Completed 1910.
Chicago & North Western	Chicago, Ill.	16	265,800	6.10	Completed 1911.
Canadian Northern Ry.	Winnipeg, Can.	6	92,205	2.12	Completed 1911.
Northern Central R. R.	Baltimore, Md.	7	71,875	1.65	Completed 1911.
Grand Trunk	Ottawa, Can.	7	86,390	1.98	Completed 1912.
Michigan Central	Detroit, Mich.	11	247,740	5.69	Completed 1913.
Delaware, Lackawanna & Western	Buffalo, N. Y.	6	86,000	1.98	Under contract 1914.
Central R. R. of N. J.	Jersey City, N. J.	20	308,040	7.07	Completed 1914.
Canadian Pacific Ry.	Montreal, Can.	11	191,664	4.40	Under contract 1914.

CHAPTER III

INTERLOCKING AND APPROACHES[1]

It is another of those paradoxes of American railway service that the enormous amounts of money spent on the vast assemblages of approach tracks of large stations with their interlocking plants and kindred accessories are needed almost exclusively for that part of the railway service which is the less remunerative, the passenger service. When it is realized that such is the case, however, it does not appear so remarkable that much of this expenditure should be needed to handle the commuter traffic which, in its turn, is the least remunerative part of the passenger service.

The efficient and economical operation of passenger terminals and trains depends in a very large degree upon:

1. The correct layout of the track approaches, consideration being given to:
    (*a*) Safety of operation.
    (*b*) Utility.
    (*c*) Reliability of operation.
    (*d*) Flexibility, allowing a quick and complete change of a route for a train movement, and,
    (*e*) Alternative routing, which may be necessary in case of derailment or other failure.
2. The proper signaling of the line approaching the terminal.
3. The simplicity and certainty of the interlocking plants controlling the terminal gateways.

A properly planned track layout and interlocking arrangement will go far toward insuring operation with proper regularity and punctuality. Many expensively constructed plants, nevertheless, have become notorious for the certainty and regularity with which they cease operation and do their best to put the commuter on the outs with the railway officers who to a large extent control his destiny. It only needs a small snow storm, some zero weather, the breaking of an interlocking connection, the blowing out of a fuse or the derailment of a pair of wheels in some of these plants to cause the whole installation to go on a strike for hours. Such suspensions of service are then often followed by many hours more of indifferent operation before the train service is again restored to normal.

Approaching large passenger terminals the main, running, lead or thoroughfare tracks fan out into a much larger number of tracks at the station. As a rule one "throat" track to six station tracks is about the correct proportion and conforms to general practice.[1] It is not advisable to allow a station but one set of throat tracks. There is an ever-present liability under such conditions, of having a heavy and important traffic congested as a result of a derailment on the throat tracks or a failure or breakage of the interlocking machinery. When there are more than six station tracks, or when more than 30 or 40 trains are handled daily, it may be considered good practice to arrange for two or more independent approaches or sets of approach tracks. In this, as in many other similar problems, the character and importance of the traffic, the average length of the trains, the number of the latter during the rush hour and the availability or proximity of other terminals are among the factors to be considered in determining the approach layout. Where business is heavy or liable to become so, parallel movements entering and leaving the terminal should invariably be planned. An interesting and reasonably flexible layout for a very narrow entrance in close quarters is that shown in Fig. 24. An approach where the width of property lines permits more liberal treatment and in which parallel movements are provided for is shown in

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[1] Written in collaboration with W. C. Follett, assistant signal engineer, New York, New Haven & Hartford.

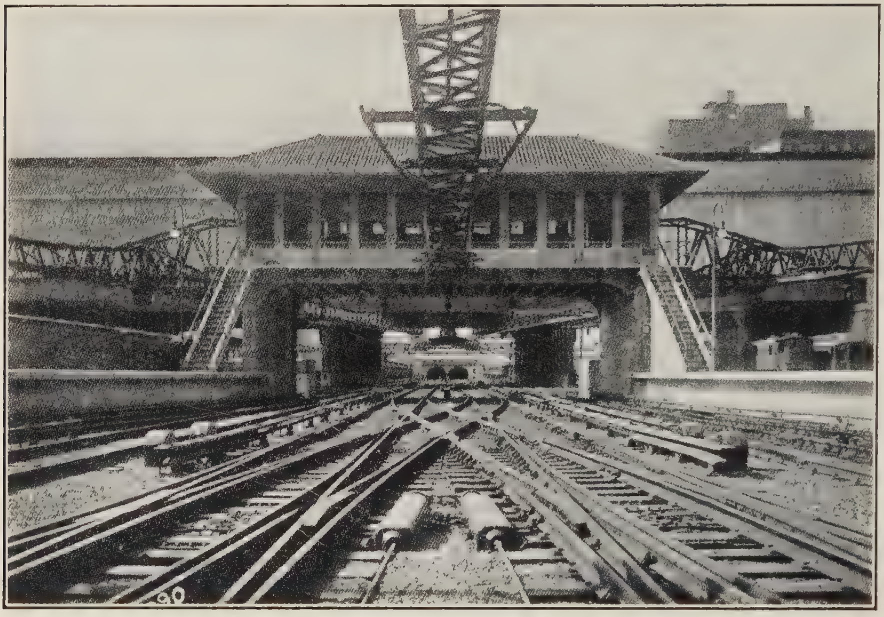

Fig. 24.—Tower "A," Pennsylvania Station, New York.

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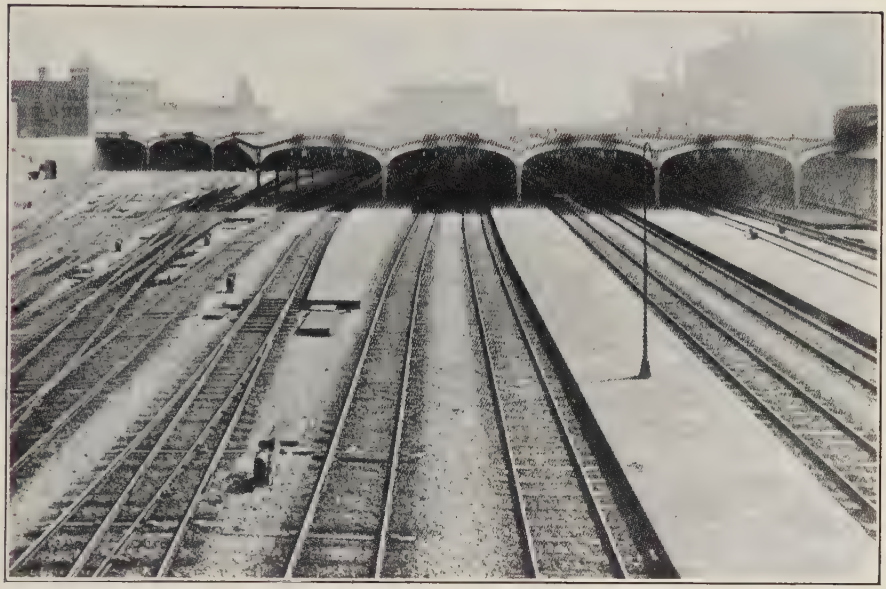
[1] In the Union Station in St. Louis, there are two separate sets of throat tracks of three each and 32 station tracks. The South Station in Boston, however, has eight throat tracks to 28 station tracks, a ratio of one throat track to three and one-half station tracks.



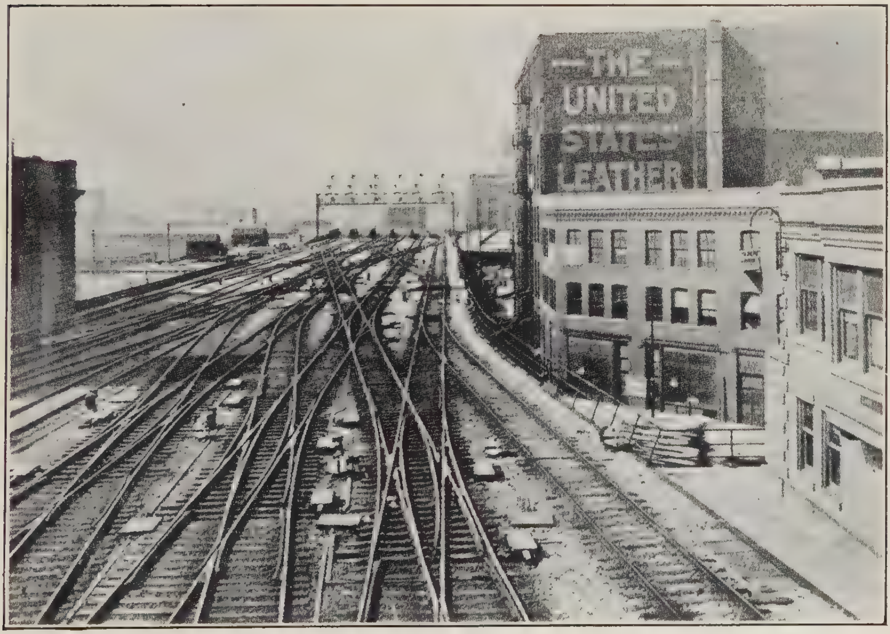


FIG. 25.—Interlocking at Chicago & North Western Terminal, Chicago.

Fig. 25. The views in this figure of the Chicago & North Western's Lake Street Station (Chicago) and close in layout show great liberality in space and opportunity to overcome difficulties caused by temporary failures.

The use of loop tracks is sometimes advantageous and reduces the necessity for providing for a greater number of single (stub) end tracks. Two loops were installed in substantially complete form in the Boston South station about 1898 but have never been used because of the inability to operate satisfactorily an underground track with steam power, and because now, were electricity to be introduced the dimensions provided would have been outgrown. The interest and depreciation on this enormous and unused investment represents today an enormous loss[1] and the proposition furnishes food for thought. It is believed, however, that loop tracks for electrically operated trains should be able to show a large saving. The designers of the Grand Central Terminal in New York have gone ahead with that in mind and hope that by the use of two loop tracks, at this writing substantially completed, on two different levels, it will be possible to secure a much greater utilization of the station tracks. A reference to the two parts of Fig. 31, showing the upper and lower levels, respectively, will make clearer the arrangement of the loops. It is planned to run the trains around the loop immediately after they are unloaded thereby emptying the tracks at the inbound platforms far more quickly than would be possible in any other way. In the case of through trains using the loop on the upper level the trains will be run to the storage tracks in the terminal or to Mott Haven yard. In the case of the suburban service, however, many of the trains will be run around the loop to outgoing tracks and there will be no delay in shifting ends or any empty mileage to and from the Mott Haven coach yards.

Interlocking machinery is the one thing that has made the large terminal an economic possibility. In common with most of our fundamental ideas in signaling, interlocking was originated in England. The first patents there were issued in 1856, but it was not until 1867 that Saxby introduced a satisfactory "preliminary latch locking." It is rather remarkable in view of later developments that in 1873 there was not one interlocking installation in the United States, but that there were in England 13,000 interlocking levers in use on the London & Northwestern alone. There is some question as to the first interlocking in the United States. According to some authorities the first installation was that of a wheel machine of the capstan type, built by the Union Switch & Signal Company in the early 70's, exhibited by that company at the centennial exhibition in Philadelphia in 1876 and afterward purchased by the owners of the present Michigan Air Line and placed in service in 1878 at Jackson, Michigan, where the Michigan Central crosses the Michigan Air

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[1] Perhaps nearly double the original construction cost.

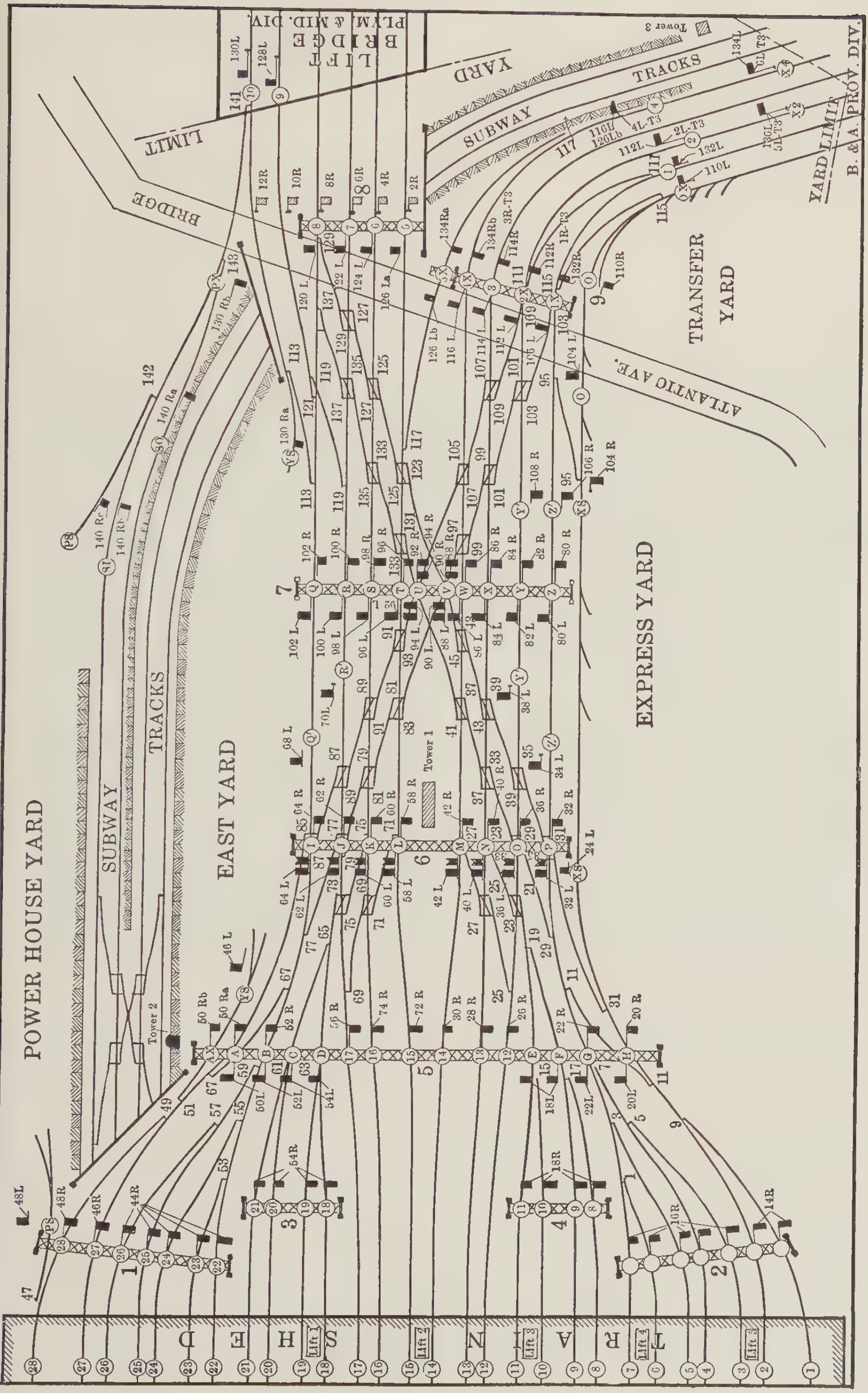


FIG. 26.—Track and signal diagram, South Station, Boston.

Line. It consists of five wheels; is of crude construction as compared with the modern lever type plants but is said to have caused no train delay in the 37 years it has been in operation.

Other authorities, however, state that the first installation was an experimental one put in service in 1874 by Toucey & Buchanan at Spuyten Duyvil, New York City and that the first installations on a commercial basis were made in 1877–8 on the Manhattan Elevated Lines in the same city by the Jackson Manufacturing Company, Harrisburg, Pa., with machines of the Saxby & Farmer type. The first power interlocking followed soon after in the form of a hydro-pneumatic plant installed in 1884 at a crossing of the Philadelphia & Reading near Bound Brook, N. J. From 1884 to 1891, 18 plants of this type, having a total of 482 levers were installed on six railroads. About 1890, however, the hydro-pneumatic system began to be superseded by the electro-pneumatic type of interlocking. This was introduced before that time, but was first applied to exacting service at the Pennsylvania Railroad's station in Jersey City. The all-electric interlocking, of which there are a number of types, dates

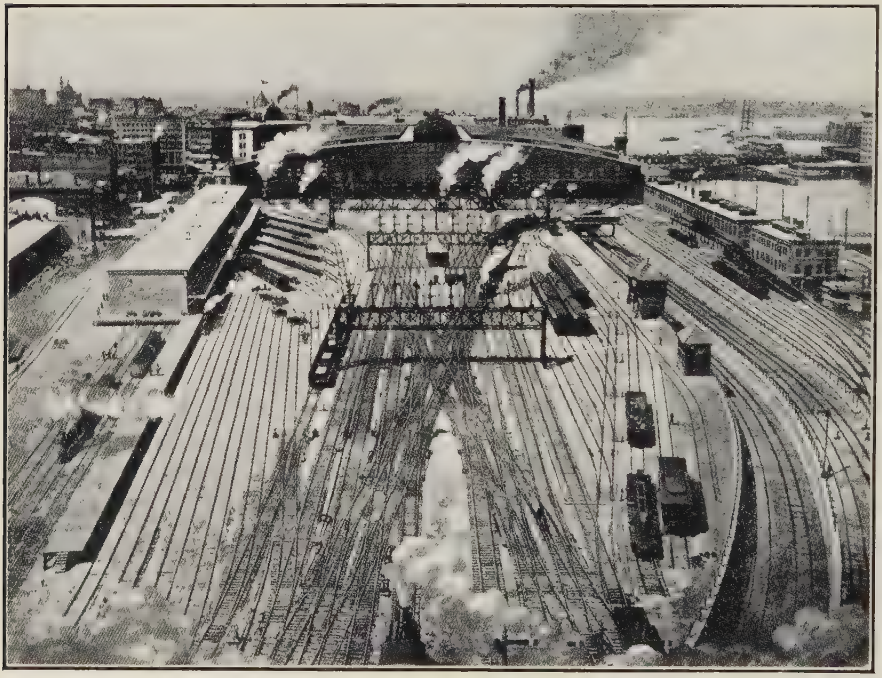


FIG. 27.—Approaches to South Station, Boston.

There are eight throat tracks over which movements pass to and from the 28 tracks in the station. Note the double line of cross leads intersecting the throat tracks from both directions, facilitating parallel movements and providing alternative routes when necessary. The depressed loop tracks (not used) can be seen at the right. The daily passenger movements in and out of this station, including regular scheduled trains, drafts to and from storage yards and light engines to and from engine houses, amount to approximately 1750, of which there are 90 regular trains between 5.00 and 6.00 P. M.

from about 1900, one of the first installations being placed in service on the Chicago, St. Paul, Minneapolis & Omaha at Eau Claire, Wis.

There are now four distinct systems of interlocking, all of which are widely used. They are: the mechanical; the electro-mechanical; the electro-pneumatic, and the all-electric. The essential characteristics of each are indicated by its name. In mechanical interlocking the switches and signals are moved by means of manual power transmitted from the tower by pipes or wires. In the electro-pneumatic plant compressed air is used as the prime mover, this compressed air being controlled by electrically operated valves. In the all-electric plant, as the name indicates, only electricity is used throughout the system. The electro-mechanical plants are a new development. As the name indicates, such a plant is a combination of the all-electric and the mechanical. Any one of the four systems mentioned may be more suitable than any of the others for certain places and under certain conditions. The third and fourth being power interlocking systems, are particularly close rivals. The all-electric type has an advantage, perhaps, from an economic and engineering point of view, while the electro-pneumatic has a good reputation gained before the all-electric entered the field. From the operating

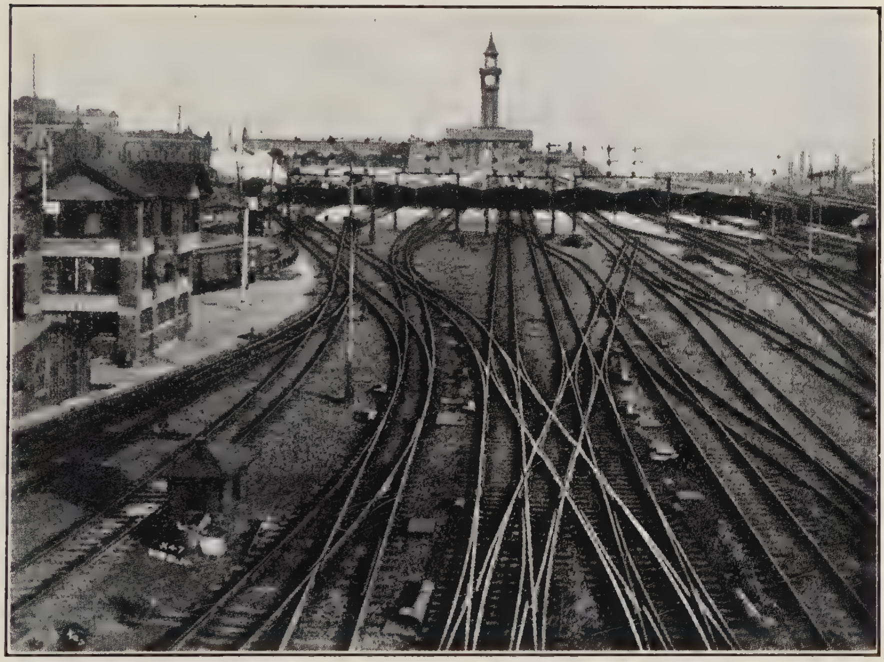


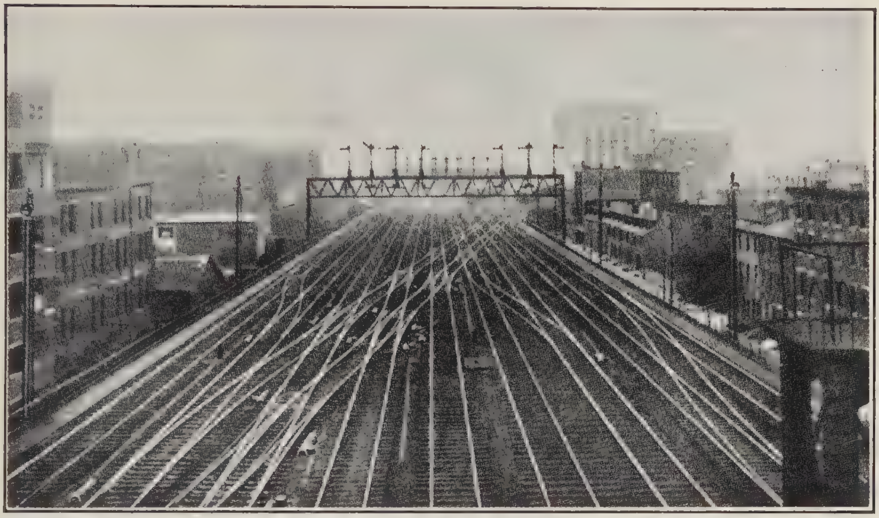
Fig. 28.—Interlocking at Lackawanna Terminal, Hoboken, N. J.

The traffic at this terminal is handled from three interlocking plants, controlling 627 signal units. From April, 1913 to April, 1914 there were 28,721,700 switch and signal operations, of which but 36 were imperfect, or one to every 797,837.

officer's point of view, aside from the element of cost, there would be little choice. The electro-mechanical and the mechanical systems are too slow in operation and too limited as to the area in which they can safely perform the required operations for use in terminal work. The mechanical interlocking is intended rather for the smaller junction points where a limited number of levers is required, say from 12 to 16 and where one attendant can readily do all the work. For a mechanical plant to work effectively the distance from the tower or central plant to the switches and signals must not be too great. Under desirable conditions such as these indicated, the mechanical apparatus is preferable because of its lower first cost and cheaper maintenance, a lower degree of skill being possible than in the maintenance of an electric plant. Some signal engineers place the maximum distance at which switches can be handled reliably and accurately by the pipe line of a mechanical plant at 1,200 ft. and the maximum distance for signals similarly at 2,000 ft.

The engineering and operating officers engaged in the construction of a large railway terminal and its approaches have to decide many important questions. Probably, with the exception of the track arrangement, they will be called upon to decide no question which will have a greater bearing on the successful operation of the terminal than that involved in the selection of an interlocking and signaling system which will safely control traffic and permit train movements with the greatest dispatch. That system will be found best in which the control of traffic will be in the hands of the smallest number of men; or in other words, that system in which the human element is reduced to a minimum. The attainment of this result necessitates the installation of power interlocking equipment preferably in one plant at the terminal, together with a complete system of automatic signaling for the approaches. A discussion of the comparative merits of the various types of power interlocking plants and signaling systems now on the market with a treatment of their comparative characteristics would, however, lead us too far afield.

In making the proper selection of a power interlocking system for a large railway terminal, there are three fundamental factors that must receive careful consideration, namely: Safety, economy and celerity of operation. The first embraces reliability. The second includes the elements of first cost, cost of operation and maintenance with a thought as to whether a very highly skilled labor will have to be called upon for either operation or maintenance. Celerity of operation relates not only to the time required to move a single unit, such as a switch or a set of movable point frogs, or to clear a signal or to the time required for the receipt of an indication at the interlocking machine but also the ability to group switches and frog units together for simultaneous movements in the setting up of routes, the latter reducing the operating time of several movements to that of one.



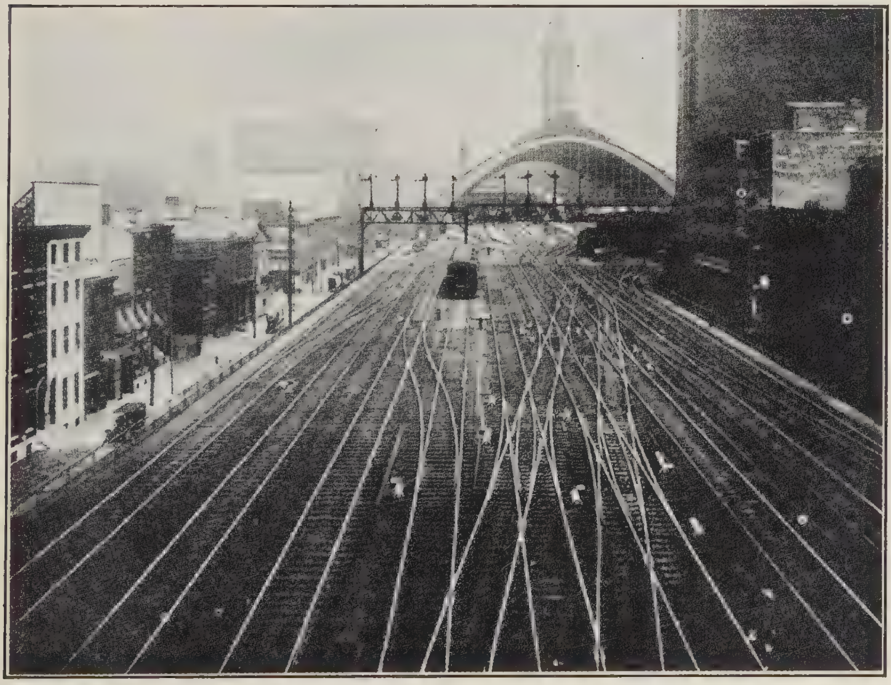


FIG. 29.—Leads to Broad Street Station, Philadelphia.

Note the double set of crossovers leading across the approach tracks. This arrangement is not universal and crossover movements can only be made from left to right except where special crossovers exist between two running tracks.

To obtain the maximum amount of safety in an interlocking plant demands simplicity and refinement. The engineer should avoid systems which have incorporated within them safety devices to prevent accident in case of irregularity. The system which requires special safety devices to prevent false movements in the event of such irregularities as crosses, broken-down insulation, grounded circuits, abnormal surges of electric current, etc., does not have the merit of a system that does not require such devices, because the protective device stands as much chance of being inoperative at the time it is needed as any other part of the system. These special safety devices appear in various forms of relays and circuit combinations. Some safety devices, however, are always necessary. Thus, in the case of a motor operated switch, the circuits should be such that a cross between any of the wires between the motor operating the switch and the contacts which control the current to the switch will either place a short circuit on the energizing line or else energize the motor so as to create a torque in the armature in the same direction in which the motor last operated.

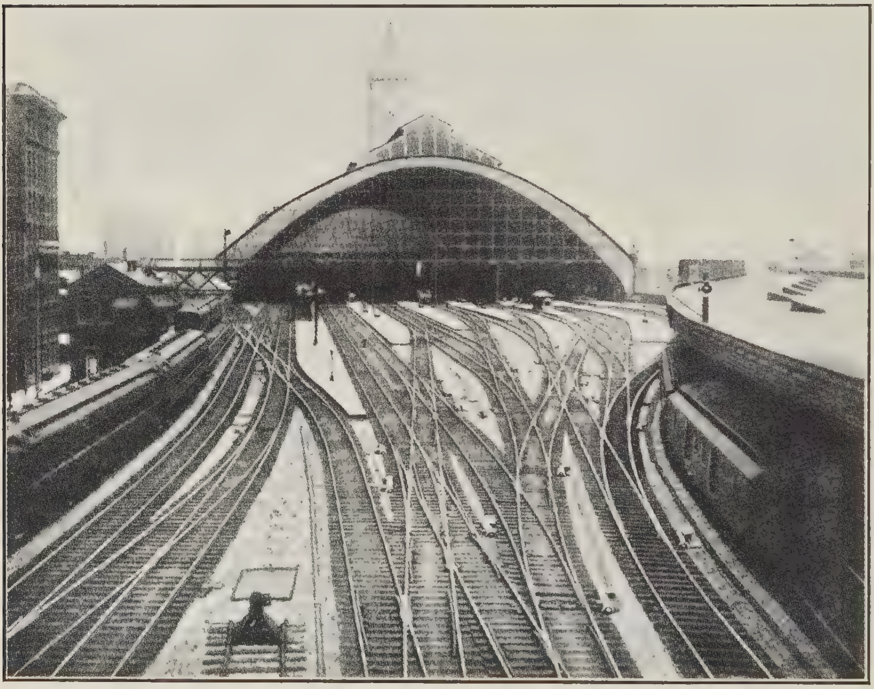


FIG. 30.—Another view of the approaches to Broad Street Station.

Switch control circuits should be so arranged that if the switch movement is operated by hand to a position not corresponding with the interlocking lever for the control of such unit, the electric motor or the air-driven piston will immediately drive the switch to the proper position and lock it so as to correspond with the position of the lever in the interlocking machine. This, of course, necessitates that the circuits be alive at all times, but may or may not require current to be actually flowing.

The safety of traffic depends largely upon the reliability of the indication circuit; hence, this is one of the most important details to bear in mind. As a matter of fact, any indication magnet when energized by electric current of the characteristic for which that magnet was designed will respond, irrespective of the source of the energy. The point that really matters, therefore, is the design of the circuit and its immunity to the effect of crosses with other circuits, the chance of falsely energizing the indication magnets, or the possibility of a false indication due to residual magnetism.

In the selection of a power interlocking plant careful consideration must not only be given to the first cost, but also to the ultimate values of the various factors which enter into the cost of operation. These include among other things continuity of service and safety. A plant properly designed from the standpoint of safety will not only keep trains from colliding, but its designers will have reduced or eliminated the possibility of minor derailments, breakages and small interruptions which total a tremendous amount in actual dollars in the course of a year. The first cost of a power interlocking plant may be considered high when the interest on the difference in cost of the high-priced and the low-priced installation is not balanced by the savings accruing from the use of the higher priced plant. The higher priced plant should show a lower cost of operation through lower charges for power, labor and maintenance. It should also produce a service of superior continuity, a greater speed in the operation of its units and possibly a more simultaneous operation of grouped units. And further, in considering the first cost, due heed should be paid to the amount of space required for the interlocking machine and power equipment, as space at terminals is usually quite valuable. Careful consideration should be given to the efficiency of the system from the standpoint; first, of the ultimate number of operations per dollar of cost of maintenance and operation (including the cost of power); and second, of the probable ratio of failures which may delay traffic to the total number of operations. This again emphasizes the element of simplicity. A plant of simple design is usually more likely to give the highest degree of operating perfection. As a rule, it is operated with less energy; less time is needed for repairs; there is less possibility of delay because of derangement and a less expensive class of attendants may be used than with the more complicated system.

Types of interlocking plants are about as numerous as the number of plants in operation; there are seldom two alike. From the simplest—perhaps the two or three lever switch machine with a lever for the switch proper; one for the lock and one for the home signal with occasionally an additional lever for a distant signal—to the machine with upward of 100 levers and all its intricate accessories is a long, long step.

The Pennsylvania opened its New York terminal at Seventh Avenue and 33d Street, November 27, 1910. A detailed description of this station with a brief reference to its approaches is given in Chapter VII. It is worth repeating here that trains are handled electrically to the station over a two track line across the Hackensack meadows from Manhattan Transfer almost eight miles out. Cabin "N" at the west end of the Manhattan Transfer platform and Cabin "S" at the east end control the loop and other tracks at the point where the change is made from steam to electric power. Cabin "N" houses a 71-lever electro-pneumatic machine having 60 working and 11 spare levers, controlling 62 signals and 44 switches in this territory with necessary locking between "N" and "S." On the upper floor of Cabin "S," there is an 83-lever electro-pneumatic machine with 58 working and 25 spare levers, controlling 67 signals and 33 switches and the necessary locking with Cabins "N" and "W," Cabin "W" being next east at Hackensack drawbridge. The train spacing is cared for by automatic signals. These are normally arranged for right-hand running, but reverse movements are provided for on either track—protection being obtained through the coöperation of the levermen and by the manipulation of a lever in the interlocking machine at each end of the automatic territory. Additional automatic signals—provided at proper intervals—are put in operation when reverse traffic is established. Between Tenth Avenue, 31st and 33d Streets and Sixth Avenue on Manhattan, some 28 acres in area, are located the station proper, and the United States post office beneath which are the tracks controlled by four signal cabins, all electro-pneumatic. The 231 signals, 45 double slips with movable point frogs, one single slip with movable point frog and 98 switches in this territory are controlled by Cabins "A," "B," "C" and "D." Cabin "A" (see Fig. 24), the largest and most important, is located east of Ninth Avenue and has 179 levers (141 working and 38 spare) operating the 124 signals, 34 double slips and 47 switches between Eighth Avenue and the east portal of the tubes under the North River. Cabin "B" has a 47-lever machine (30 working and 17 spare) controlling 26 signals, 4 double slips and 14 switches. Cabin "C" has a 47-lever machine (36 working and 11 spare) controlling 28 signals, 6 double slips and 14 switches. Cabin "D" has a 71-lever machine (51 working and 20 spare) controlling 43 signals, 5 double slips, one single slip and 23 switches. Between 34th Street and Sunnyside Yard on Long Island are Cabins "F," "H," "O" and "R" constructed and operated similarly to those described in the foregoing. A summary of this signaling is shown in the table in Fig. 35.

A detailed description of the Grand Central Terminal in New York will also be found in Chapter VII. A plan of the track layout and approaches will be found in Fig. 31. To operate all the switches and signals on the two levels of this station there are five all-electric interlocking plants.

Interlocking station "U," located at 57th Street, has 144 levers and controls all movements to and from the terminal and to or from both levels.

Interlocking station "A" having 360 levers, is located under Park Avenue at 50th Street, on the upper level and controls all movements to or from the station and storage tracks west of track 16 on the upper level to interlocking station "C" and to upper level loop.

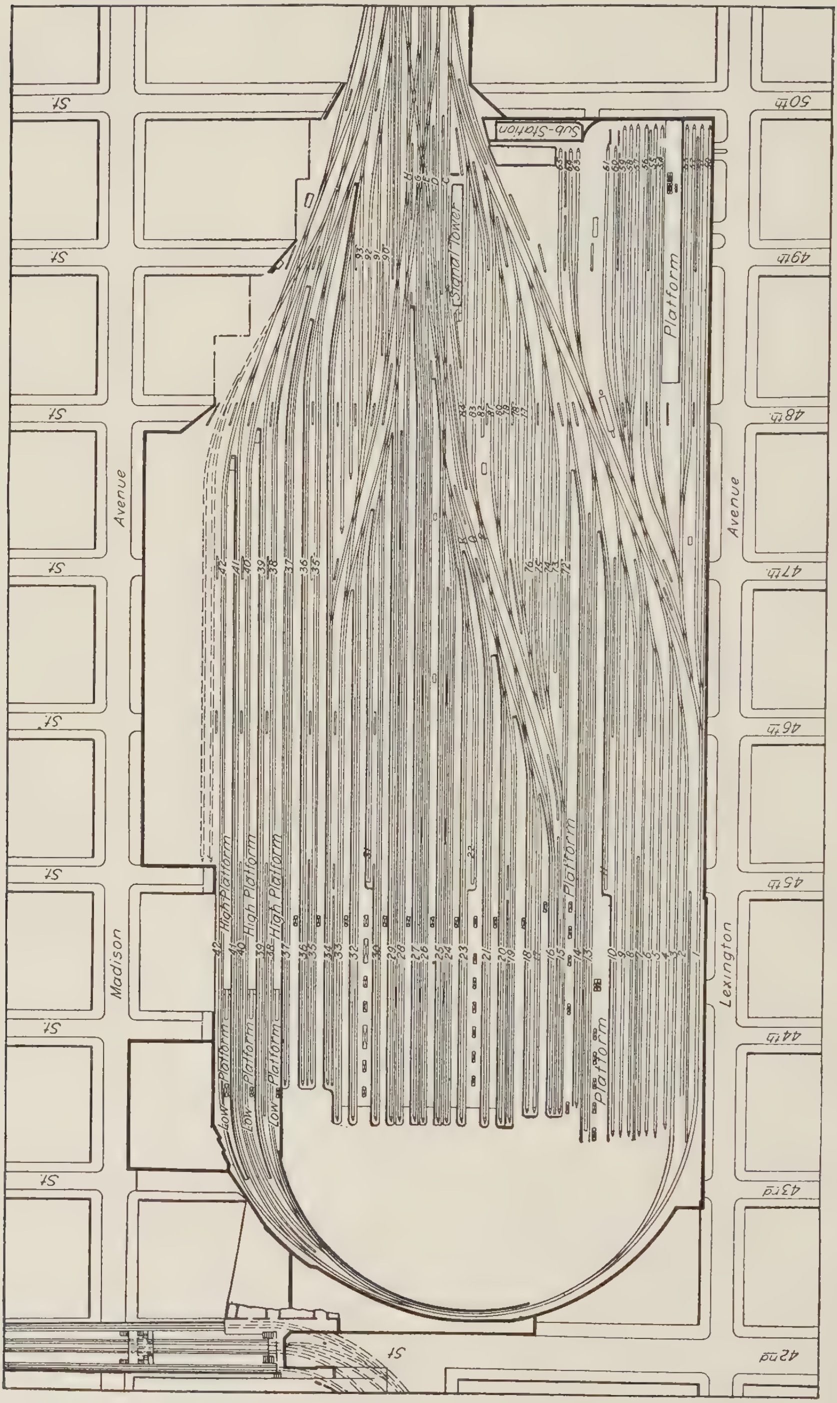
Interlocking station "C," a 160-lever plant, is located under 48th Street near the east side of the terminal on the upper level, and controls all movements to and from the storage tracks east of track 16, from storage tracks to yard number 2 and from the upper level loop.

Interlocking station "B" a 400-lever plant located on the lower level under Park Avenue at 50th Street, controls all movements on the lower level except those around the loops.

Interlocking station "F" with 80 levers, is located on the lower level near the east end of the loops, and controls all movements around the loop tracks in both directions on both levels.

In addition to the five main interlocking stations there are 12 sub-interlocking stations located at various points throughout the terminal, for the purpose of localizing and housing relays and track apparatus. These stations are equipped with terminal boards for distributing circuits to the various units in the immediate vicinity.

The importance of the interlocking plant and the value of substantial construction and proper design cannot be made clearer in a better way than by a review of the rather exciting experiences of the Boston & Maine when Tower "A" at its North Station in Boston was completely destroyed by fire on the morning of January 14, 1914. The tower was not fire-proof (evidently); it contained a 119-lever electro-pneumatic machine which controlled the yards and the drawbridge in the immediate vicinity. After the fire had destroyed the old machine it was decided to install a 131-lever machine. The order was placed on January 16 and the machine was shipped from the factory by express on February 4. As the new machine was larger than the old one, in addition to erecting a new building, a complete new dog chart and locking and combination sheets had to be made along with a design of a new track model as the yard layout had been changed since the old machine was installed. The new machine arrived in Boston on the morning of February 6, and at 10.45 A. M. the first crate went into the tower window, 25 hours and 40 minutes after it had left the factory at Swissvale, near Pittsburgh, Pa. The machine was set up by the Boston & Maine's signal department; tested out, and placed in service at 9 P. M. on February 8.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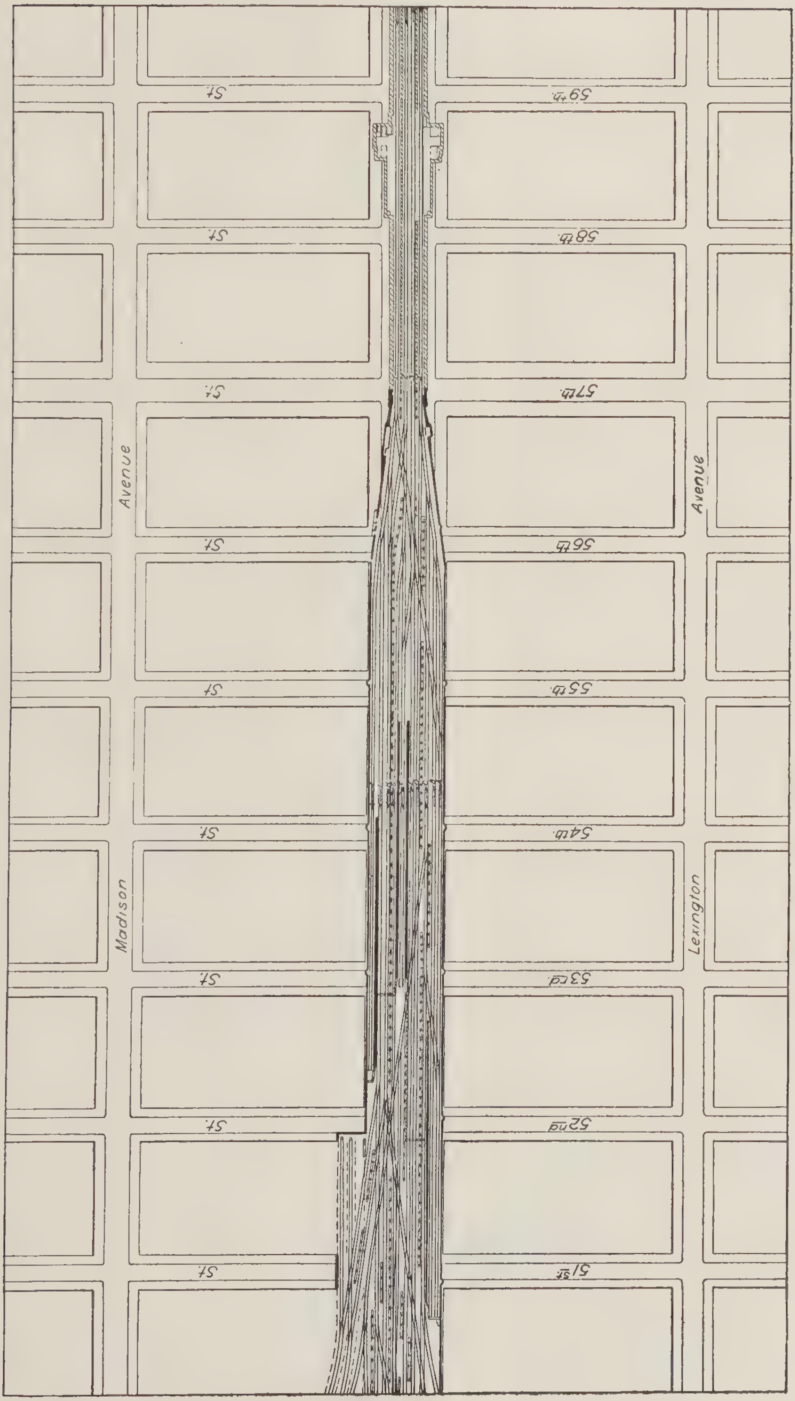
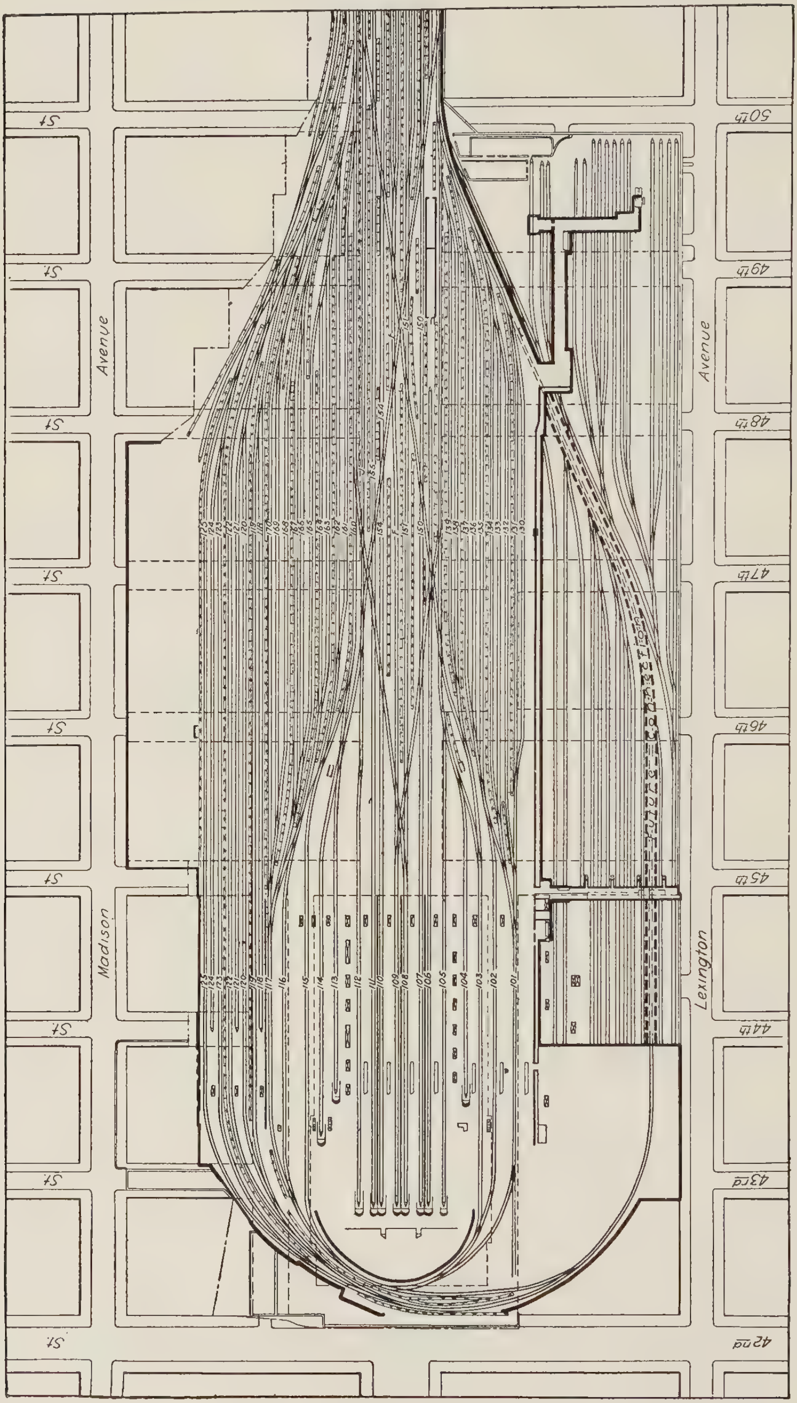


FIG. 31A.—Plan of tracks and approaches to Grand Central Terminal, New York—upper level.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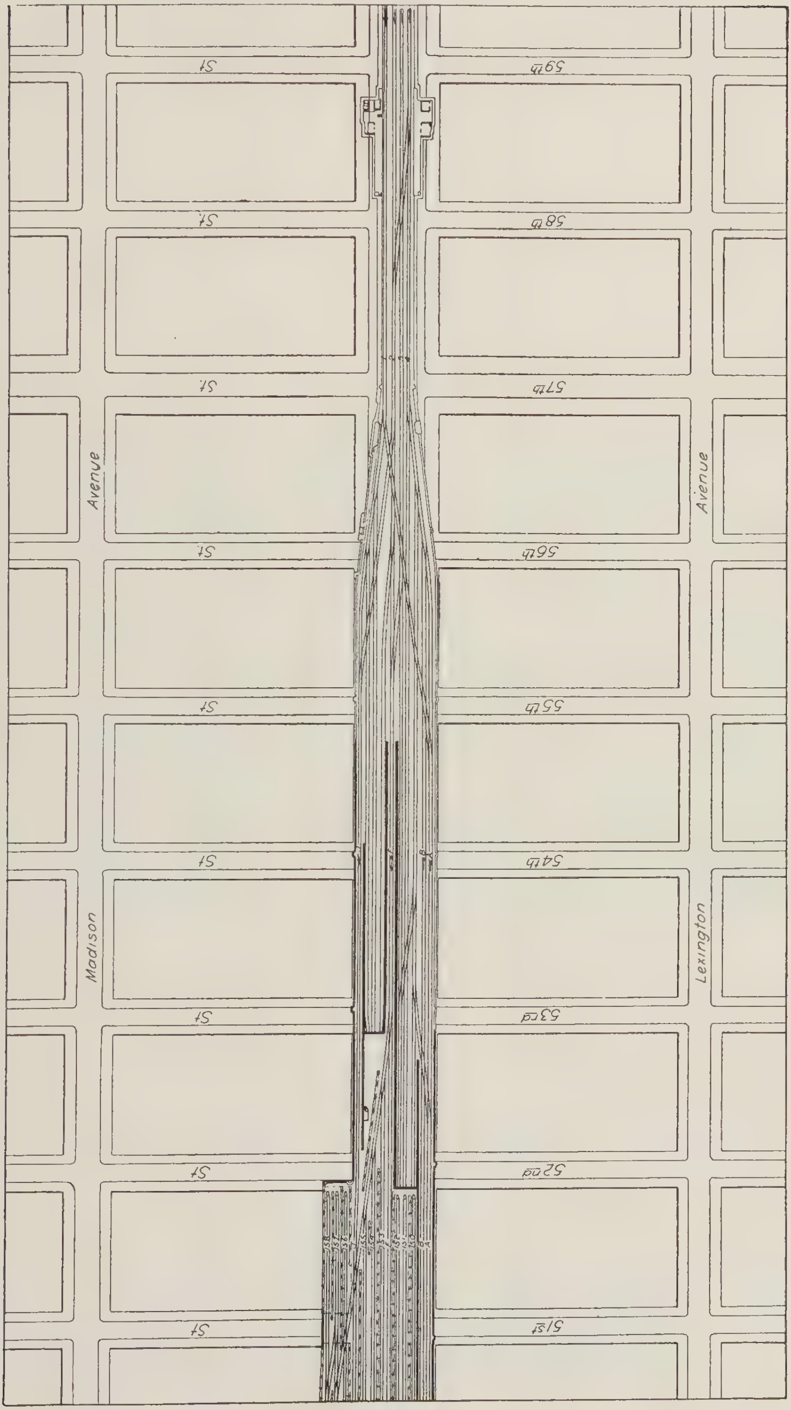

FIG. 31*B*.—Plan of tracks and approaches to Grand Central Terminal, New York—lower level.

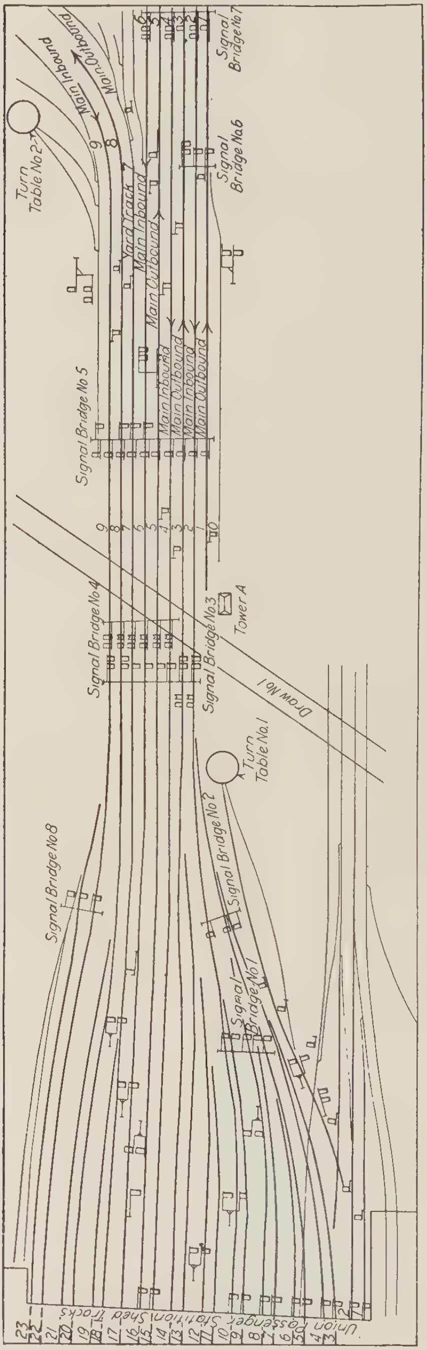

FIG. 32.—North Station, Boston—track and signal diagram.

Following the loss of the old plant, it was necessary to discontinue 279 passenger trains in the daily schedule, because of the curtailment of facilities. The old Fitchburg station was opened to take care of the Fitchburg division passenger trains, interfering with its freight traffic. The Portland Division eastern route trains were sent out by the "back way" through the Portland Division freight yard, interfering considerably with that freight traffic. Between the time the old plant was destroyed, January 14 and the new one placed in service, February 8, the electro-pneumatic switches in the terminal were operated by manipulating the valves by hand, necessitating the employment of about 140 extra men.

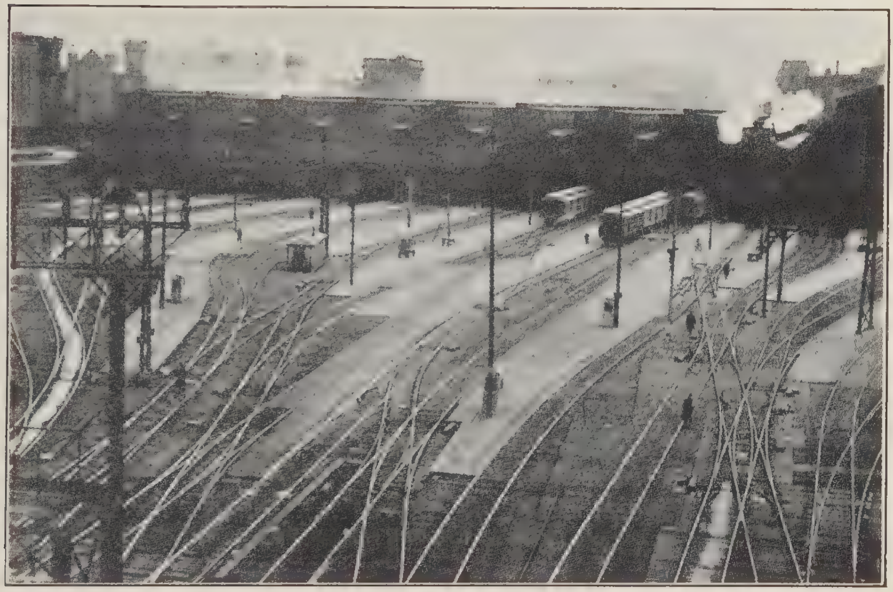

Fig. 33.—Approaches to North Station, Boston.

The automatic signaling system controlling the approaches and main lines leading to a larger terminal is a very important factor in the successful operation of that terminal. The engineering and operating officers when laying out the approaches and arranging the signaling for the control of traffic over them must consider not only the present requirements but the general business prospects and probable growth of the community together with other factors that enter into the commercial environment and the probable trend of business growth. Obviously, the signaling for lines into New York, over which there is a large passenger business, a great proportion of which is commuter service, as well as an enormous freight service of great variety, will not be the same as that needed for lines into Pittsburgh where the predominating business is in heavy freight commodities like iron and coal. Or to carry it further, any signaling system must pay due heed to the class of trains and the speed at which they run. Its designers must consider whether all trains will travel at the same speed or whether there will be a freight service, an exceedingly fast passenger service and a slower suburban service. The schedules, the braking power of the equipment, the accelerating power, whether steam or electric traction or both are to be used, the physical conditions such as grades, curves, tunnels and drawbridges, and the weather conditions such as the frequency of fogs, lightning storms, extreme cold weather, etc., must all be given their due importance.

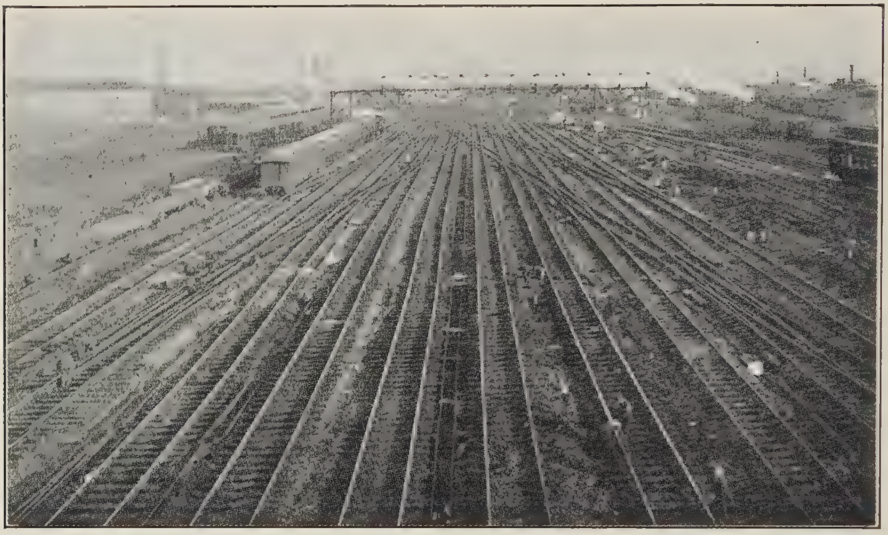

Fig. 34.—Approaches to Jersey Central Station, Jersey City.

The arrangement of the signals should be especially dependent upon speed, and trains should be so governed that they may operate at predetermined speeds irrespective of the route over which they are to travel. Furthermore, the trains approaching a large terminal should be automatically reduced in speed and admitted to the terminal at the rate of speed and frequency for which the terminal's facilities have been designed. In this way, the choking of traffic on the throat tracks will be automatically prevented and arrangements will be such that the station will be able to sort and classify the approaching traffic as fast as the automatic signaling system will permit that traffic to approach the terminal.

In rush hours the celerity with which trains are dispatched from a terminal is largely dependent upon the spacing of trains after they have left the terminal limits. To a certain extent the length of the blocks should increase as the distance from the station increases. This is dependent, on the one hand, partly upon the accelerating factor of the trains and, on the other, upon the frequency of trains leaving the terminal,

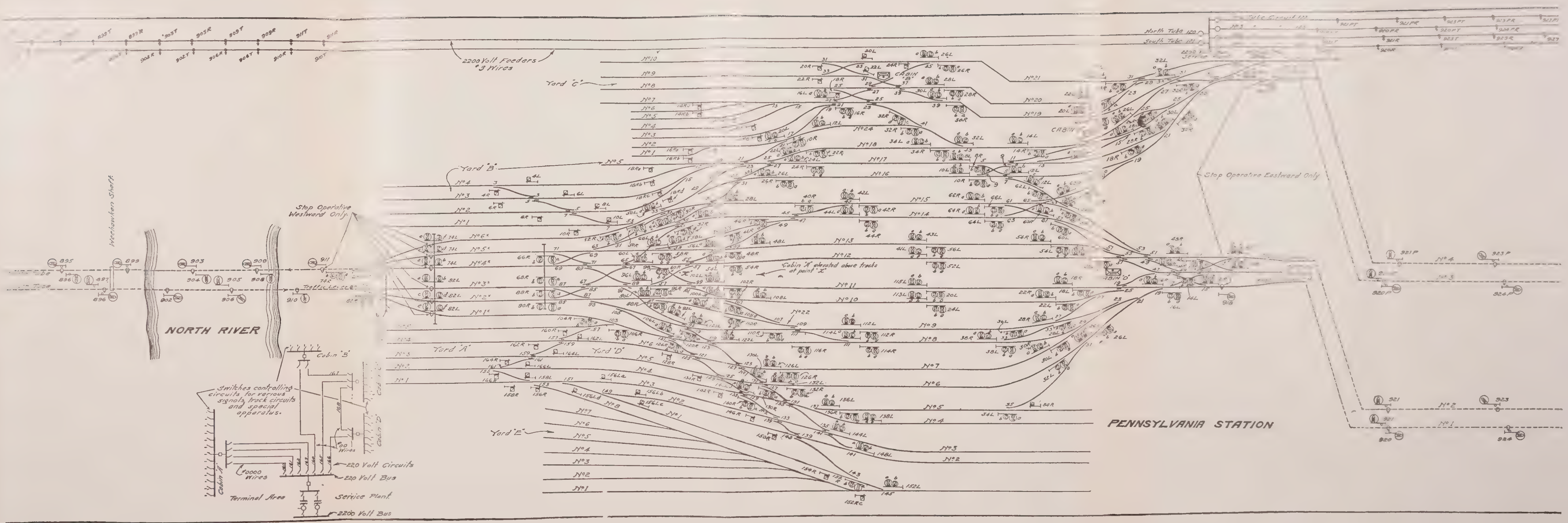

Fig. 35.—Interlooking layout, Pennsylvania Station, New York.

(Facing page 62.)

together with the rate of speed at which they are permitted to travel in the terminal limits. It is often found advantageous to install an intermediate interlocking plant at the outer end of the throat leads for the purpose of securing flexibility in the handling of traffic at the terminal, and by arranging a system of signaling through the throat tracks so that traffic may be operated in either direction as pre-arranged by the operators. This greatly facilitates movements in congested hours and during times of abnormal conditions. Such a plant is usually made a part of the automatic signal system so far as the spacing of traffic and control of the approaches are concerned.

Where two classes of service are to be controlled by an automatic signal system, that is, a suburban service at approximately 30 to 35 miles an hour over the same tracks with a high speed through traffic at approximately 65 to 70 miles an hour, it is necessary to arrange the blocks so as to space the trains properly at both speeds. This is accomplished by speed signaling. All signals are equipped with two blades. A train operating at 30 miles an hour would apply the brakes when passing a signal, the aspect of which would indicate: "Pass this signal prepared to stop at the next signal," whereas the fast train would be governed by the additional aspect on the first signal to the rear which would indicate, "pass this signal prepared to pass the next signal at medium speed." Then having reached the next signal at medium speed it would have the same indication and braking distance as the suburban train at approximately the same speed.

In selecting an automatic signal system the same general factors must be considered as in the selection of interlocking apparatus. The factors of safety and economy have practically the same significance.

Aside from the fundamental factors that enter into the construction and development of an automatic signal system, probably the most important is the question of electric power. Probably at all terminals in this country and in most cases throughout the surrounding territory there is a network of low-voltage direct-current street or interurban traction lines, and a part of the energy generated at the power station for these street railway lines will invariably return to its original source over the tracks of the terminal and approaches. The presence of this direct current in the tracks of a steam road presents a certain hazard in the use of direct-current signal equipment which should be avoided, and which can be avoided by the use of alternating current for the signal system.

Obviously, if alternating current is to be used for track circuit purposes it is only good engineering and economical management to operate everything in connection with the signal system from the same source of energy. Therefore, the complete system should be operated by alternating current. This includes not only the automatic signals and the track circuits of the terminal, but also the entire interlocking equipment. In planning the power system for a terminal the primary thought should be continuity of service, and secondarily, economy. In most large terminals a power plant is part of the equipment, and if possible, the signal engineer should arrange to take the source of energy from the terminal plant purely as a matter of economy even though he may have to transform the current used for the general terminal apparatus into various other forms and characteristics in order to adapt it to get the best results from the signaling system. The most economical and approved system is to operate the entire signal equipment, including the entire interlocking apparatus, automatic signals, and all accessories that function in connection with the signaling system by alternating current of predetermined characteristics and to arrange for the continuity of this service as the importance of the equipment may demand. At a terminal interlocking where the interruption of traffic for 15 or 20 seconds would not seriously interfere with the train schedule and the general service to the public, the auxiliary equipment may consist of a motor generator normally standing idle together with a bank of storage batteries of ample capacity to furnish the necessary current for a predetermined time as may be necessary to re-establish the normal alternating-current supply. This auxiliary machinery is meant to operate automatically in case the power from the primary source is dis-

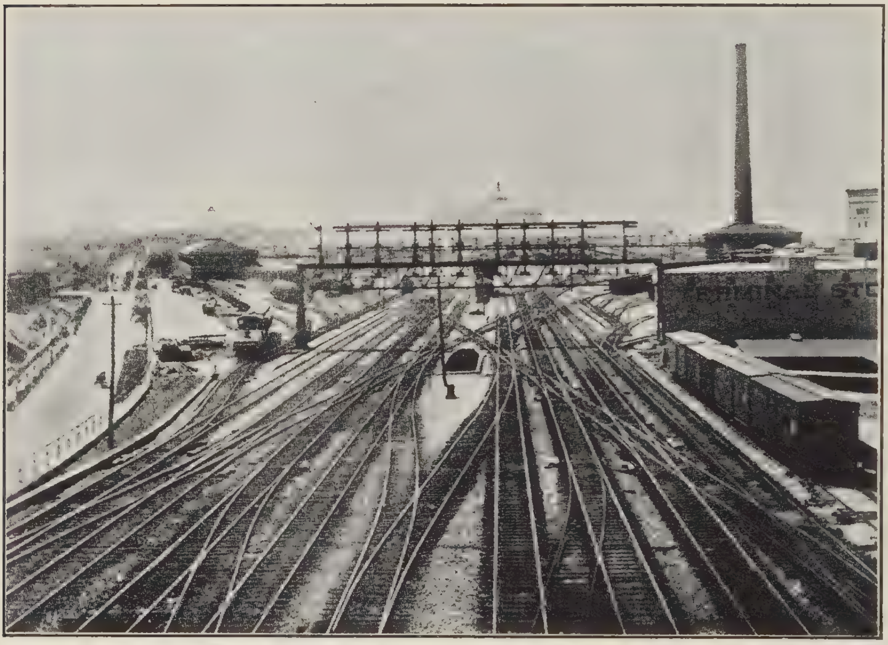

Fig. 36.—Approach tracks to Union Station, Washington. Parallel and alternative routes are provided.

continued. If, however, the importance of the service is such as to make it necessary to have absolutely continuous service, the power supply to the system should be from a continuously operated motor generator with a bank of storage batteries floated across a direct-current member, thus assuring an uninterrupted service to the signal system irrespective of interruptions to the primary source. Usually at terminal points the signal system extends beyond the point where continuity of service must be continuous. At such points the electric power service rendered is usually of sufficient reliability so that no auxiliary machinery is necessary in connection with the signal system. In such cases there is a large saving in auxiliary power equipment.

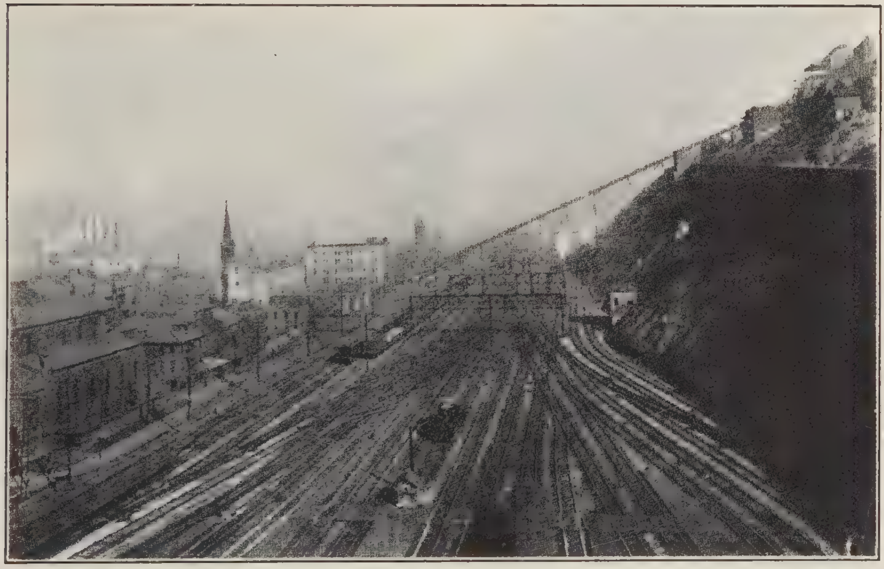

FIG. 37.—Looking eastward from Pennsylvania Railroad Terminal, Pittsburgh. There is double line of crossover tracks running in both directions from right to left and from left to right, providing facilities for parallel and alternative movements in either direction.

Line signaling is usually designed as closely as may be in accordance with the recommended practices of the Railway Signal Association, with such modifications as local conditions may make advisable or necessary. "Necessity is the mother of invention" and it is also said "knows no laws." Inability to follow along conventional lines frequently develops the latent initiative and results in long steps in advance. Just as the New York, New Haven & Hartford, somewhere in 1898 or 1899, following an unsatisfactory confusion of an outside white light with a white (proceed) light of a fixed signal, was the pioneer in introducing the yellow light as a caution signal and thereby allowing green to be used for proceed, so that same road with its peculiar and unparalleled New England conditions (mental, moral and physical) during the past few years was again compelled to take an absolutely independent and fearless lead in introducing the so-called "center-hung" semaphore signal, the "day-light" signal for main-line work and the upper left-hand quadrant, three-position signal. The center-hung and the daylight signals were born of necessity; they were introduced because the overhead structure carrying the wires for the single-phase alternating-current electrification[1] did not allow sufficient clearance for the ordinary standard semaphore signal blade.

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[1] Paradoxical as it may seem, the conservative New Haven road, in conservative New England, was, and is, also the pioneer in the world, in introducing electric operation on a large scale for suburban and through passenger and freight and yard service. This, however, is treated in greater detail in Chapter XVII.

CHAPTER IV

THROUGH OR SIDE STATIONS

A through or side station is a station whose principal tracks are continued through the structure so that a train proceeding in either direction may continue its run in the same relative direction without reverse movement. Stations of this type include the vast majority. In this particular chapter, however, we shall confine our attention to the more important through stations found in the larger cities and shall leave the lesser ones to the chapter on Small or Local Stations. It should be noted that while the through stations are vast in number, they include but one of, let us say, the five or ten largest and busiest terminals. The one exception is the Pennsylvania Terminal in New York City, which has, perhaps with one exception, the greatest capacity of any station in the world, but whose business as yet is comparatively small in volume and entirely of an end-of-the-line character. The larger stations of this country are almost entirely head stations. The reason does not appear to lie in any particular advantages that the latter type of station may have. It results largely from the limitations or needs of the communities in which these larger terminals are built.

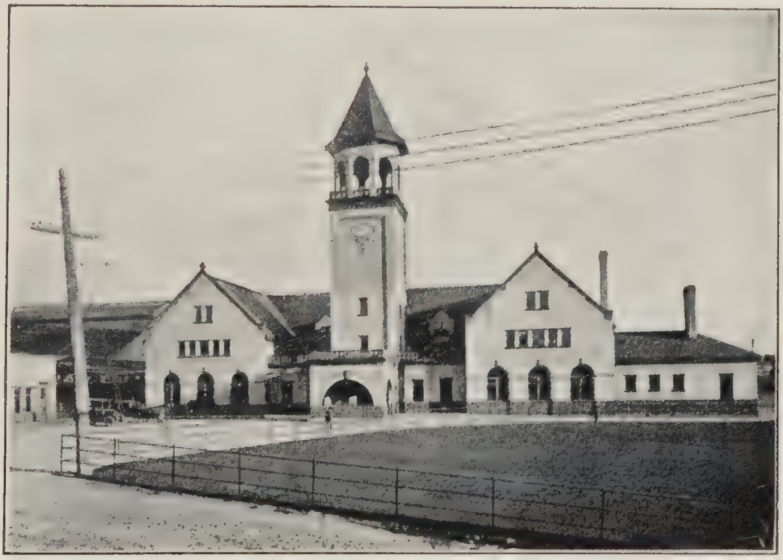


Fig. 38.—Station at Bangor, Me.

On the whole it is impossible to argue in favor of either one or the other type of structure. The head station is little else than an absolute nuisance when it has to be used for through traffic. The choice of either one or the other type of station in the case of any community is a distinct problem in itself. In the larger cities, such as New York, Chicago or Philadelphia, the larger proportion of the traffic consists of commuters, while another large percentage consists of persons who are coming to or going from the city. That part of the total, which would find it useful to use the through station, is small and, even of that small number, many would find it necessary to use two stations unless perchance there were but one enormous terminal for all the city's railroads. In cases where the pressure in favor of the through station is so slight it is hardly worth while for any railroad owning a long strip of land ending at a strategic point in the city's business center to extend that strip. It is entirely different in cities like Cleveland, Kansas City or Albany where the prime necessity is for facilities which will permit passengers to proceed in the same general direction with as little inconvenience as possible.

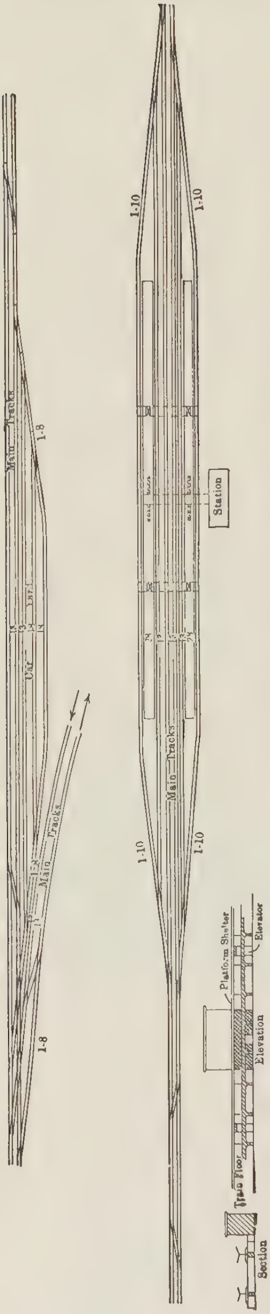


Fig. 39.—Typical track layout for through station, American Railway Engineering Association.

Through stations may be divided in a general way into three types according to the level of the railway tracks as compared with that of the surrounding streets:

1. Tracks and streets at the same level.
2. Tracks at a higher level than the streets.
3. Tracks at a lower level than the streets.

Typical stations of the first kind are found in the Delaware, Lackawanna & Western station at Scranton, Pa., and the Union Station at Memphis, Tenn. The second type is illustrated in the new Union Station in Worcester, Mass., and in the New York, New Haven & Hartford station in Providence, R. I. Representative of the third class are the Pennsylvania Terminal in New York City and the Union Station in Kansas City.

The recommended layout of the American Railway Engineering

Association for through passenger stations is shown in Fig. 39. It will be noted that a separate station platform is provided in this particular two-track arrangement for movements of trains in each direction. All trains stopping at the station must be switched from one of the two main tracks to one side or the other of one of these platforms so that the main tracks are clear while the stop is being made.

The Bangor, Me., station of the Maine Central and the Bangor & Aroostook, illustrated in Fig. 38, is a typical through station of the first type. The station building proper, a plan of which is shown in Fig. 40, is 154 ft. long and 82 ft. wide with a wing 29 ft. by 40 ft. It is built of buff-colored brick with brownstone trimmings and base. The tower on the front, 130 ft. high, gives an imposing effect to the structure. The principal entrance is defined by a porte-cochere and beyond this entrance, which is about 18 ft. square, there is a vestibule through which one passes to the main waiting room, 41 ft. by 84 ft. This is connected with the dining room by a wide passageway. In the extension are the kitchen and a store room. The women's retiring room, with toilet room adjoining, is in the main part of the building to the right of the vestibule, and the ticket office, agent's office, news stand, smoking room and men's toilet are on the opposite side. The train shed is 500 ft. long and 100 ft. wide. It covers eight tracks, five of which are stub and three are through. The platforms between the tracks and the station building are 25 ft. wide. The baggage, mail and express rooms are in a separate building, 250 ft. by 30 ft., to the east of the station; baggage has to be trucked across the tracks at grade.

The Union station at Meridian, Miss., is used by the Southern, the Mobile & Ohio, the Alabama & Vicksburg, the Alabama Great Southern and the New Orleans & Northeastern. The station's style of architecture is an adaption of the old mission. There is a main building with a low square tower, a front portico, 20 ft. wide, a broad porte-cochere, 89 ft. wide and 169 ft. long and two end wings, each 112 ft. in length, so that the station proper extends along the track a distance of 394 ft. The exterior of the building has a dark red brick base, 5 ft. high, built on a flare. Above that the walls are of brick covered with pure white stucco, with a medium rough cast finish. The roof extends over the walls and being of red tile produces a remarkable effect because of the contrast to the plain white walls. On the side of the station toward the tracks there is a glass-covered concourse, 40 ft. wide, running the full length of the building. Between the tracks there are two platforms, 19 ft. wide and 1,100 ft. long, and one other of the same width, 720 ft. long. The general waiting room is in the two-story central portion. It is 46 ft. by 110 ft. and extends the full height up to the roof. From this room there are openings leading to all the other rooms and passages. The ticket office occupies a position accessible from all points in the center and has a

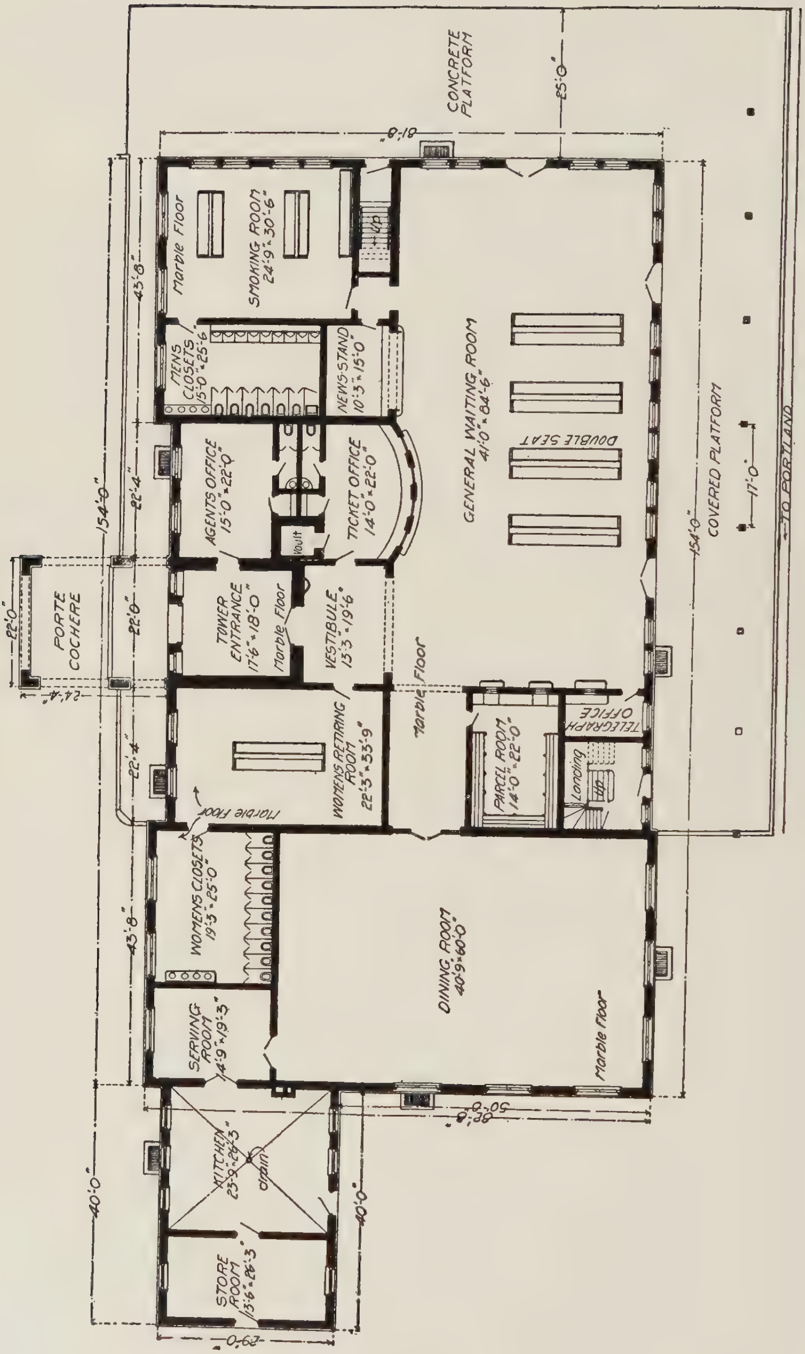


FIG. 40.—Plan of Bangor, Me. Station.

storage room and toilet. Opposite it are the news stand and the parcel room and telephone booths. There are also a ladies' parlor, a men's smoking room, and the usual separate rooms for negroes necessary in any southern station. The two one-story wings are separated from the main building by wide passageways. The left wing contains separate lunch rooms for white people and negroes, a telegraph office, rooms for the mail and the news company and a rest room for conductors and trainmen. The right wing is devoted entirely to the handling of baggage and has large checking windows directly opposite the main waiting room. Express is handled in a building, 50 ft. by 125 ft., separated from the other by a 125-ft. wagon space, the building being connected with the concourse and the train platforms by cement walks and platforms.

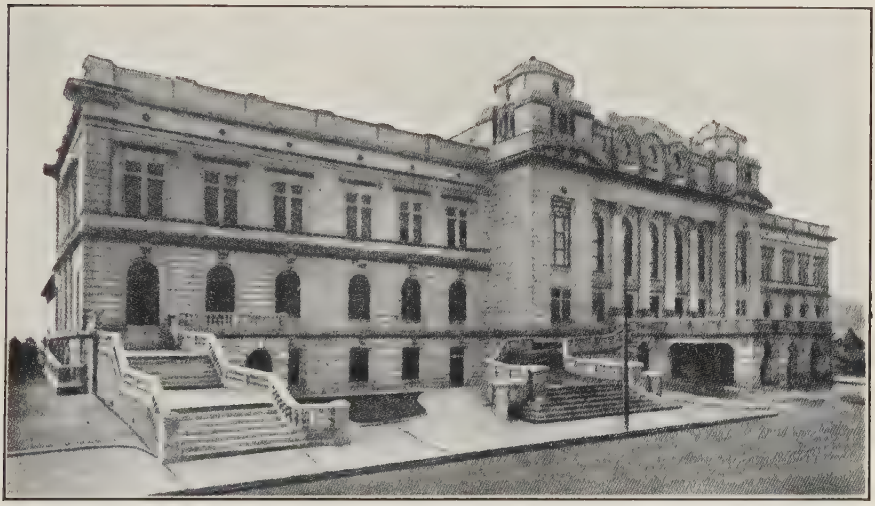


Fig. 41.—Union Station, Memphis.

The station at Memphis, Tenn., was opened for business on April 1, 1912. It is used by the St. Louis, Iron Mountain & Southern, the St. Louis Southwestern, the Southern, the Louisville & Nashville and the Nashville, Chattanooga & St. Louis. The main building is in early Italian Renaissance style and the exterior finish includes Vermont granite and Bedford limestone. The building is 84 ft. wide, 285 ft. long and three stories high. The central portion is surmounted by twin towers connected by a smaller upper story. In front there is a crescent-shaped staircase rising to a broad balcony over the porte-cochere. The northeastern corner of the building is approached by a separate stairway provided for the accommodation of colored passengers who may thus enter their waiting rooms directly. The main waiting room is 76 ft. by 100 ft. The walls are finished in tiling and in native Italian marble, green and brown predominating. On two sides there are wide balconies from which one may obtain a good view of Memphis on the east, or the yards on the south. Facing the waiting room are the ticket offices, telegraph offices, baggage and parcel rooms, the news stand, Pullman offices and information booth. The ladies' waiting room opens from the main room. A lunch room, also, adjoins the waiting room. Colored passengers use a separate waiting room, 39 ft. by 69 ft., in which the facilities in the main waiting room are duplicated.

The concourse of the station is 95 ft. wide and 241 ft. long. It is on the same level with the waiting room and roomy and well ventilated. A direct exit connects it with the street. The train sheds are of the butterfly type, built of steel and reinforced concrete.

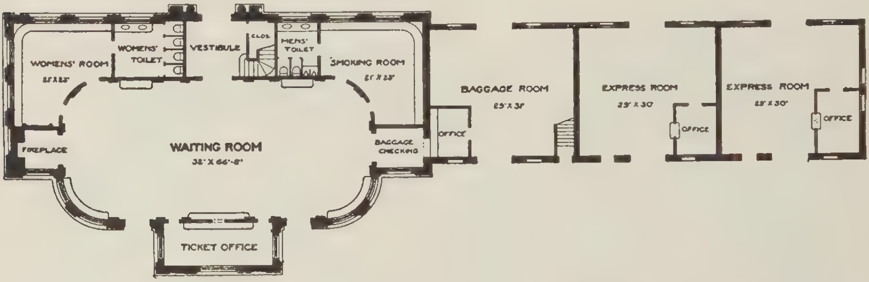


FIG. 42.—Plan of station at Grand Junction, Col.

Baggage is handled in a room on the ground floor, 64 ft. by 88 ft., supplemented by another room, about one-half as large, and an annexed baggage room, 75 ft. by 240 ft. The last is connected by tubes with the baggage check room adjoining the main waiting room. All baggage is taken to trains through a subway, 15 ft. wide, running the entire length of the track yard, connected by cross subways to hydraulic elevators between the tracks. On the ground floor there are also mail rooms, offices for the express companies, locker and rest rooms. Express is handled in an annex, 40 ft. by 275 ft.

A plan of the Grand Junction, Col., passenger station of the Denver & Rio Grande is shown in Fig. 42. This station serves a community of only 8,000 people and was opened in the spring of 1906. The exterior of the building is a fine example of the French Renaissance. The body of the walls consists of hard burned rich buff brick standing out in marked contrast to trimmings of light terra cotta and a roof of rich red clay tiles. The main building is two stories high and contains the waiting room and like facilities. The ticket office is in a one-story porch and faces the waiting room on the side toward the tracks. To the right of the main building, and as one stands back to the tracks, there is a long wing containing the baggage room and two express rooms. It is planned in the future to build a similar wing on the left containing a lunch room, kitchen and a large open pavilion. On the second floor rooms are provided for the division superintendent's offices, trainmen's rooms and despatchers and telegraph offices. The station has no train shed, the dry mild climate of Grand Junction making such protection unnecessary.

The view in Fig. 43 shows the main entrance of the Lackawanna station and office building at Scranton, Pa. The building was erected in 1909. It is 80 ft. wide, 250 ft. long and five stories high. The style of architecture is French Renaissance with the somewhat unique feature of a continuous marquise, 20 ft. wide, which extends along three sides of the building. Fig. 44 shows a view of the main waiting room. It is worth noting that this is very similar to the Lackawanna station at Hoboken in its general scheme and more particularly in its balcony, arrangement of seats and illumination. The ticket offices, news stand and telegraph office lead from the waiting room and are directly opposite the main entrance. The lunch and dining rooms are adjoining on the east end, on which side there are also the women's retiring room, the men's smoking room and telephone booths. At the west end of the waiting room there is an additional exit provided to relieve the traffic between the

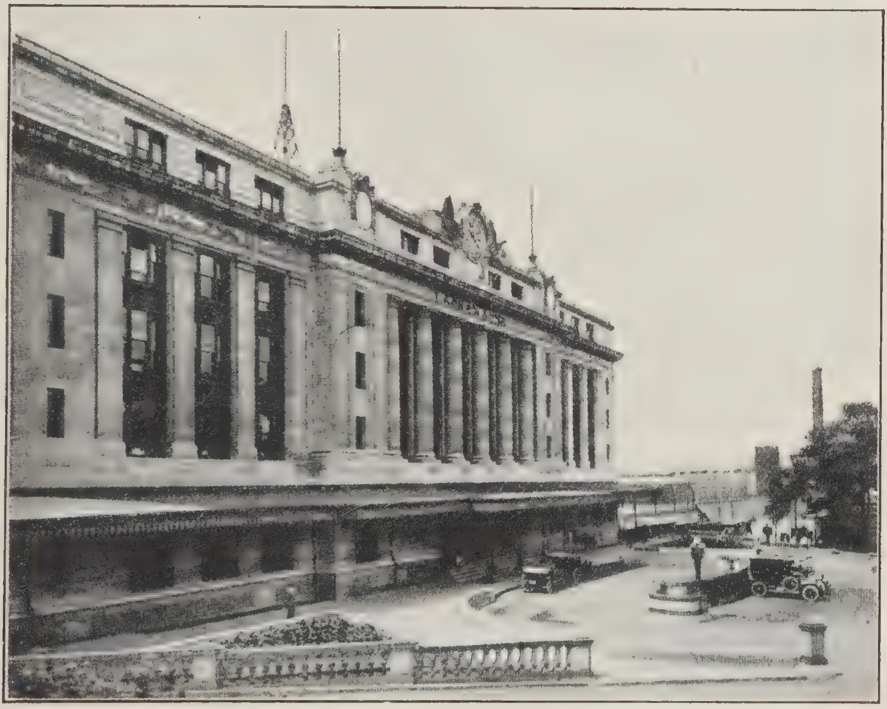


Fig. 43.—Lackawanna Station at Scranton, Pa.

street and train concourse. The main baggage room, the hand baggage room and the offices of the transfer agent and the station master are to the west of that passage. The upper part of the building contains many of the company's general offices. This station was one of the first to be provided with the Bush train shed, a detailed description of which was given in Chap. II. A view of the particular installation at this place is shown in Fig. 22.

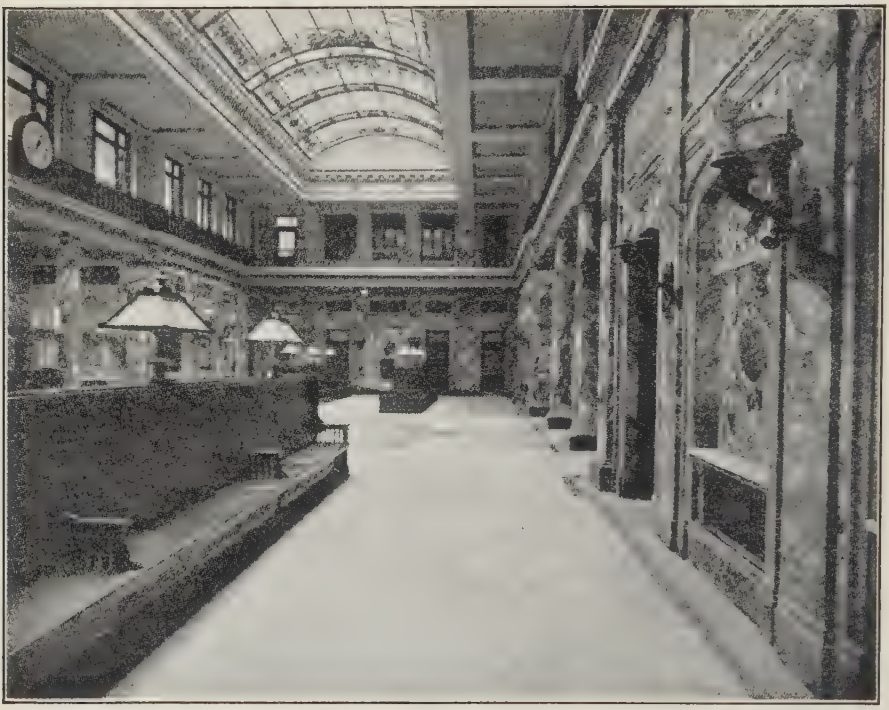


Fig. 44.—Waiting room of Scranton Station.

Other interesting examples of through stations of the first type are to be found in the proposed New Haven station at New Haven, Conn., in the Union station of the Oregon Short Line at Salt Lake City, in the Burlington station at Omaha and in the Albuquerque station of the Santa Fe.

According to the notation adopted stations of the second type are those with the tracks above the level of the surrounding streets.

The Providence, R. I., station of the New York, New Haven & Hartford is one of the most convenient and elastic stations for handling varying volumes of traffic. It has made a good showing in many seasons of very heavy travel. It has been in operation since 1899, and is now handling about 11,000,000 passengers annually—an average of about

30,000 a day—which number is frequently more than doubled. About 330 trains are handled daily including 30 New York-Boston express trains, about 180 local steam and about 120 multiple unit electric trains. Three prominent streets are crossed by the tracks at the station which is located in the heart of the city. With an adjacent system of parks and the large business, municipal and state buildings the terminal constitutes one of the beautiful city entrances or gateways of this country. A view of the station is shown in Fig. 45.

There was much controversy when the station was built as to whether a head or through station should be erected, and the plan as adopted was a compromise embracing the essential features of both to avoid the contention that a "Chinese Wall" was to be built dividing the city. A large main thoroughfare, Francis Street, 110 ft. wide, was laid out, which, in addition to Gaspee Street to the east and Promenade Street to the west of the station layout, gave a new direct commodious highway of easy grade from the center to the northern part of the city. A surface station would have prevented this. The plan in Fig. 46 is that of the new Promenade Street interlocking plant which controls the east end of the station. It gives an accurate idea of the track layout. Of the five stub tracks on the south side, four, A, B, C and D, are assigned to electric trains and one track, X, to express. Fourteen tracks were provided in the station, four at each end, eight in all, being stub tracks. Within the past few years and with the completion of the tunnel and the addition

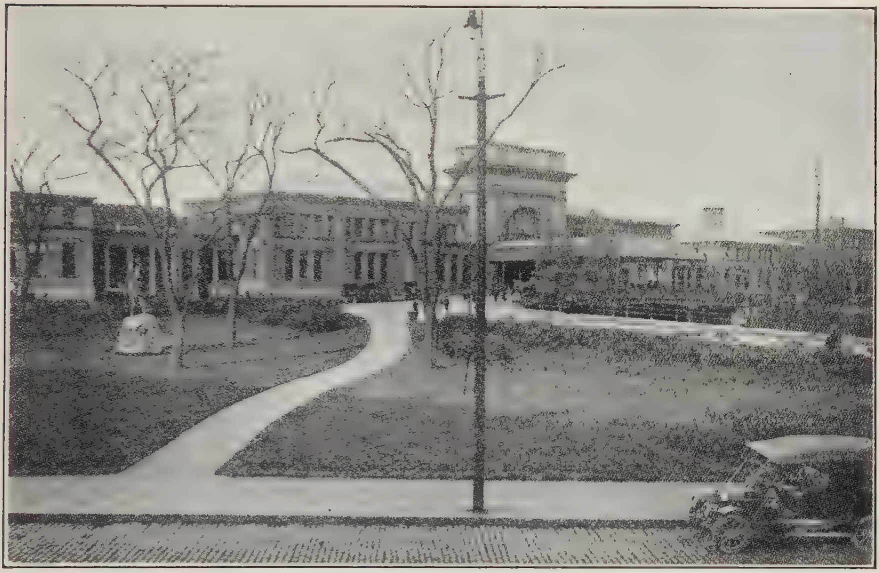
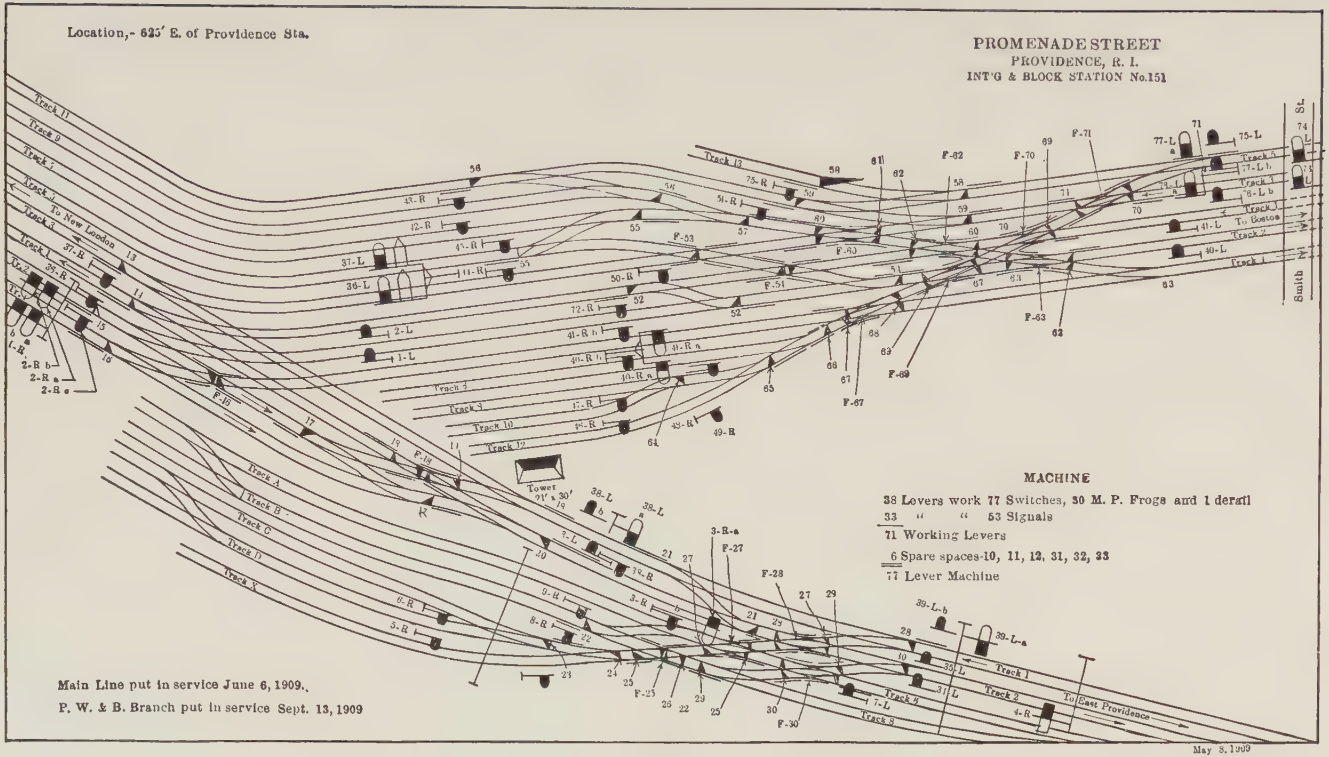


Fig. 45.—Station at Providence, R. I.

of electric train service along Narragansett Bay, two additional tracks have been laid out, making a total of 16. Passengers may reach the stub or through tracks by passing through the colonnade to the right and left of the main waiting room without entering the waiting room, thus relieving congestion during the rush hours. There are six through tracks for through train movements besides two freight tracks outside of the train shed. The tracks are laid in pairs on 12-ft. centers, and the distance between adjacent tracks of each pair is 30 ft. on centers, leaving the platforms, 20 ft. wide. The station is of the Renaissance style of architecture and is divided into groups, there being five separate buildings. Three of these are connected with each other and with the station proper by colonnades or roofed passageways. The central building is 110 ft. by 220 ft. and is one story high. It contains the waiting rooms, toilet rooms, ticket offices, the cab office, etc. On each side there is a two-story building, 72 ft. by 84 ft., connected with the central building by a colonnade having a roof supported by columns of polished granite. The one on the east is for baggage and has the trainmen's quarters overhead; the one on the west was intended for a restaurant. In the middle of the street front of the main building, there is a low heavy tower with a porte-cochere in front of the main entrance; to the right and left of the station proper there are two separate four-story buildings, 65 ft. by 125 ft. The one on the right is used for express and freight offices and the one on the left is the railroad office building. The total length of the group of buildings is 870 ft. and the width varies from 65 to 100 ft.

The floors of the front vestibule, the main waiting room and the inclines leading to the colonnades and train platforms are of concrete with thrown marble mosaic covering. This covering was laid without pattern in the center but has an 18-in. border of colored marbles laid to line and geometrical pattern in the main waiting room, and a 12-in. border in the restaurant. The floors of all the water-closets are of granolithic; those of the colonnades and inclines leading to the subways are of Trinidad asphalt. The smoking and women's rooms are finished in 2½-in. tongued and grooved long leaf Georgia hard pine, close laid and blind nailed to strips imbedded in concrete. The ground floor areas are: central building 25,500 sq. ft.; restaurant building, 5,900 sq. ft.; baggage building, 5,900 sq. ft.; office building, 7,500 sq. ft.; express building, 7,500 sq. ft. The main waiting room is 60 ft. by 218 ft., the baggage and restaurant rooms are each 70 ft. square. The use of inclines to avoid steps is extensive. Passengers in the main waiting room can go directly to the main platforms or to the stairways leading to the subways. This room was placed 2 ft. lower than the through platforms, this difference being overcome by an incline which is hardly noticeable between the main waiting room and the main concourse. The subways are 10 ft. below track level which is overcome by the use of



Location,- 625′ E. of Providence Sta.

PROMENADE STREET
PROVIDENCE, R. I.
INT'G & BLOCK STATION No.151

MACHINE
38 Levers work 77 Switches, 30 M. P. Frogs and 1 derail
33 " " 53 Signals
71 Working Levers
6 Spare spaces-10, 11, 12, 31, 32, 33
77 Lever Machine

Main Line put in service June 6, 1909.
P. W. & B. Branch put in service Sept. 13, 1909

May 8, 1909

Fig. 46.—Plan of tracks in Providence Station

stairways having 19 steps. The latter are the only steps a passenger has to use in reaching any train in the station. The train shed covers an area of 75,000 sq. ft.

The Providence station is an especially flexible and convenient through arrangement. There might, however, better be but one building instead of a group of five, for thus the cost of heating, maintaining, cleaning, etc., would be reduced. Moreover, with the additional stories needed less elevator service would be required. Offices could be more conveniently located with reference to each other. There would be less actual obstruction to streets, two cross thoroughfares outside the building probably serving instead of three. One subway, perhaps larger than the present ones, would have materially simplified the directing of passengers to their trains and reduced the cost of attendants required for that purpose.

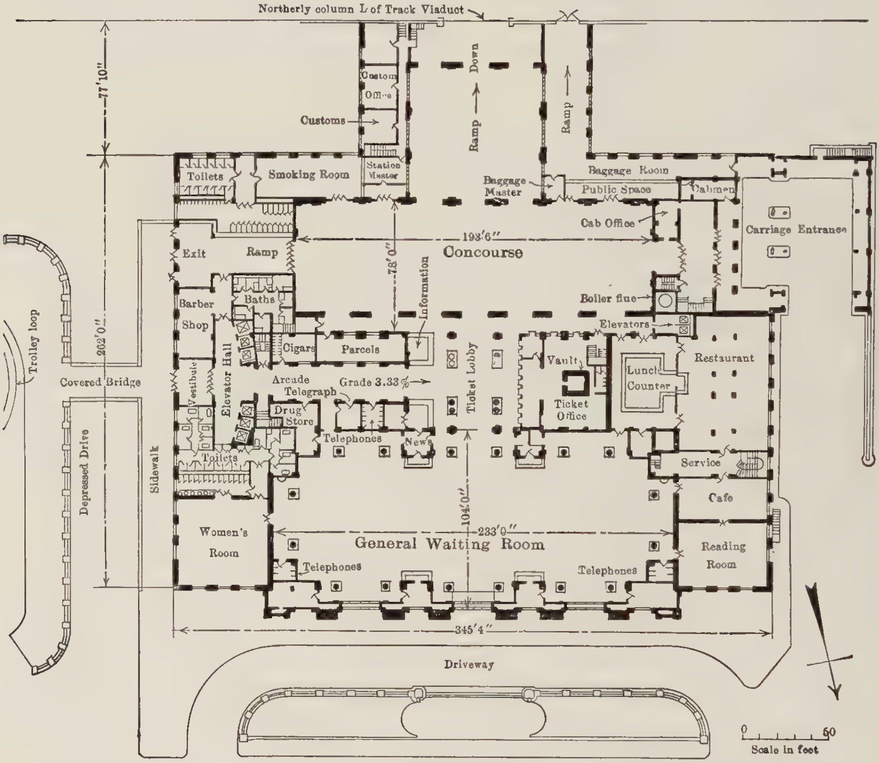


FIG. 47.—Floor plan of Michigan Central Station, Detroit.

Nevertheless, the system of inclines used to avoid stairways as far as possible is most excellent, and in their general use the Providence station doubtless stands as a pioneer.

The Detroit station of the Michigan Central was opened on December 27, 1913. It includes a 15-story office building and was built with the object of avoiding the objectionable reverse movement made necessary by the location of the old station. It forms a part of the extensive passenger and freight terminal improvements which the Michigan Central now has under way at Detroit.

The station is about 1½ miles from the center of the city but readily accessible from all the city's car lines. An exterior view of the structure will be found in Fig. 11 and a map of the general layout in Fig. 145.

The station building, 345 ft. long and 262 ft. wide, is rectangular to the height of the top of the waiting room, 76 ft. from the ground. It is I-shaped above, for the office building is but 54 ft. wide with sections at each end 108 ft. wide and 54 ft. long. The total height is 230 ft. On the exterior, granite is used to the height of the window sills of the main floor, blue limestone to the sills of the first office floor, a light-colored pressed brick to the twelfth floor and terra cotta above that. The main entrance fronting on the specially constructed Depot Esplanade is covered by a marquise, and on the front of the building there are three arched windows 21 ft. wide and 40 ft. high.

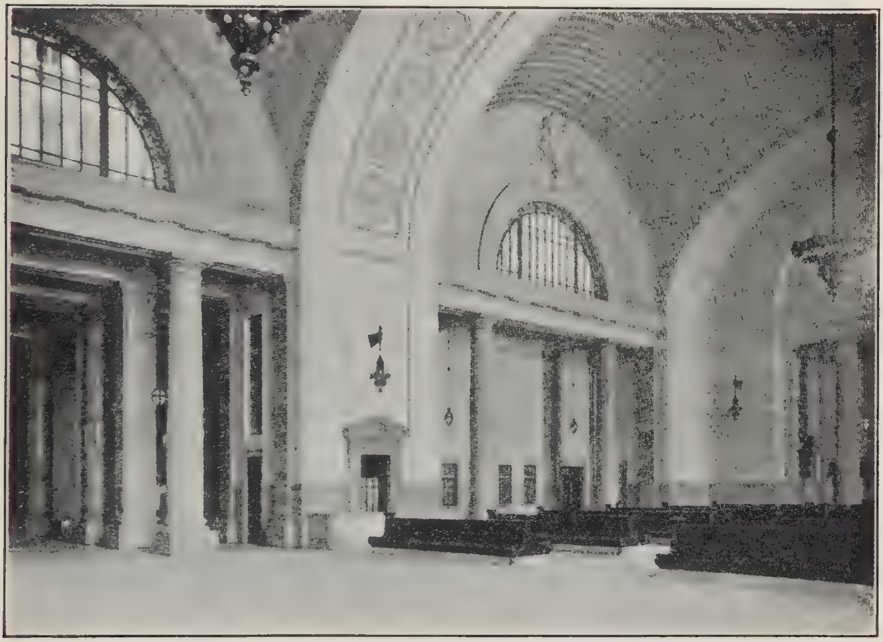


Fig. 48.—Waiting room of Detroit Station.

One enters directly from the main entrance into the general waiting room, 104 ft. by 233 ft. On the opposite side from the entrance there is a small ticket lobby with ticket offices on its right. The news counter and information desk are opposite. This lobby can also be reached by means of an arcade leading from the east side of the station on which the car loop is found. The larger portion of the users of the station, therefore, do not have to enter through the waiting room.

The station concourse, 78 ft. by 193 ft., occupies a position analogous to that of the waiting room on the opposite side of the ticket lobby, and entrance to it is primarily through the ticket lobby. There is also a carriage entrance on the west side of the concourse and a separate exit on the east.

The various station facilities are rather scattered. The women's room, with toilets connected, is on the east side of the waiting room and can be entered from it only. The men's smoking room is at the southeast corner of the concourse and can be entered from the concourse only. On the opposite side of the exit from the concourse to the street is a barber shop. Closely connected with it there are eight bath and dressing rooms for out-of-town patrons who may not wish to go to a hotel. There are five similar rooms connected with the women's room.

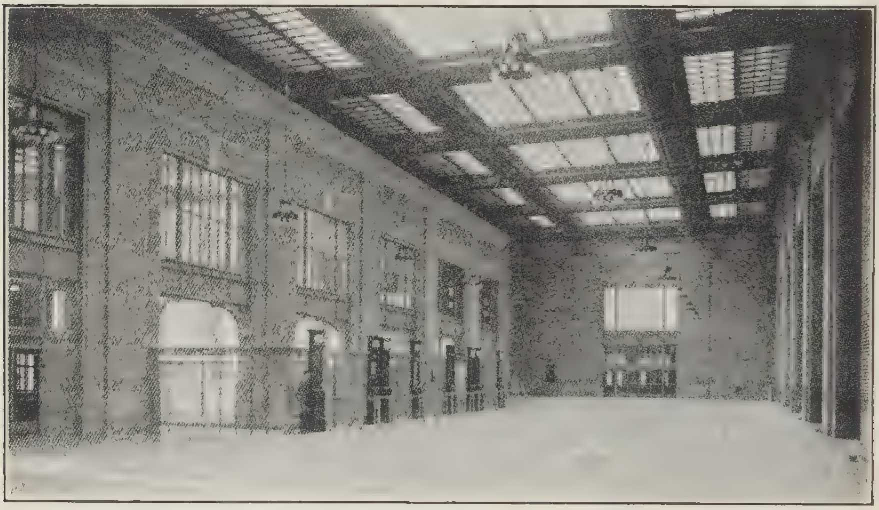


Fig. 49.—Detroit Station concourse.

A drug store is to be found on the entrance arcade. Directly opposite there is a cigar stand. The lunch counter and restaurant are found in the space behind the ticket office. There is also a café on the west side of the waiting room. A men's reading room adjacent to but not a part of this café is exceedingly well fitted and provided with an abundance of good reading matter.

The baggage room is on the concourse, parallel to it and on its left-hand side as one faces the tracks. The parcel check room is on the concourse and also on the entrance arcade.

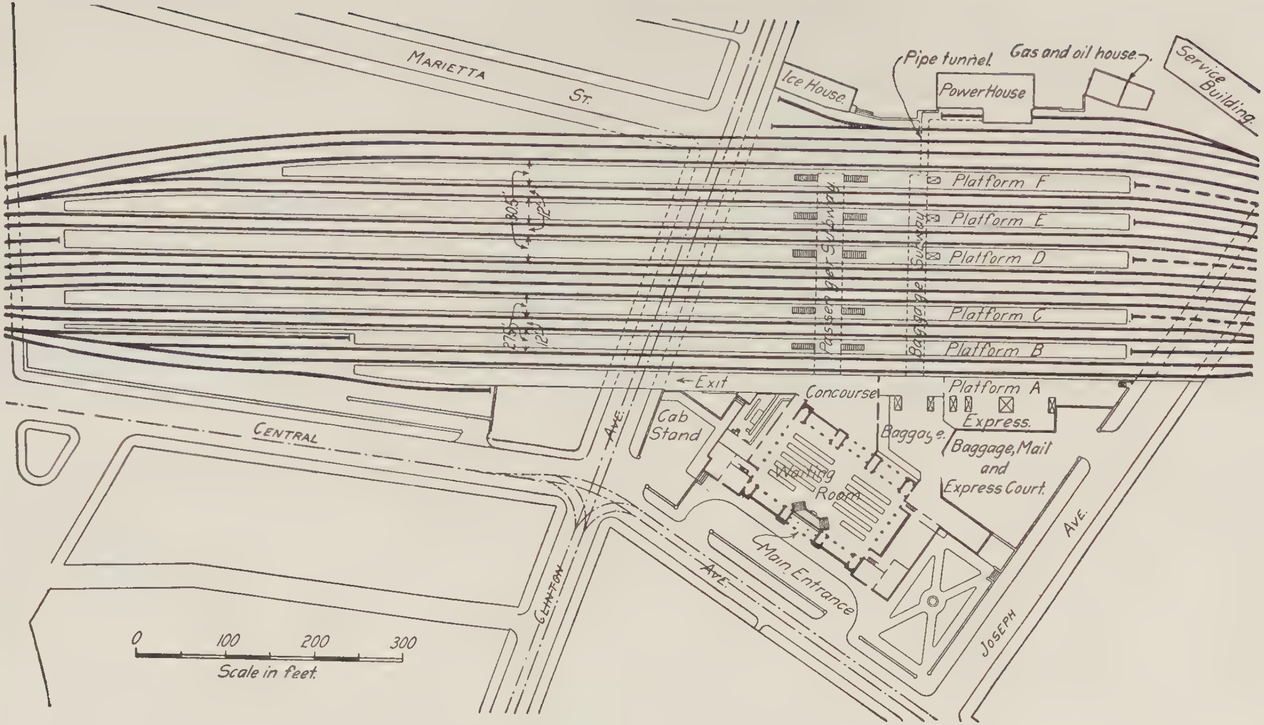


FIG. 50.—Plan of New York Central Station, Rochester, N. Y.

The station has 10 through passenger tracks and one express track. The former are arranged in pairs, 12 ft. on centers, and 28 ft. between adjoining pairs so that 19-ft. platforms are used. The Bush train shed is 1,100 ft. long at its longest part. Some of the platforms, however, are 1,400 ft. long.

The station platforms are reached by a subway on a 7 per cent. incline down from the station, 76 ft. wide at its entrance and 40 ft. wide and 8 ft. high under the tracks. There are two flights of stairs from the subway to each platform. Train indicators are placed at the foot of the stairways and since there are doors passengers may be held there until trains are ready.

The baggage and mail rooms are under the tracks. The express room is adjacent, being under the freight tracks or just north of the station. Baggage is trucked from the baggage room in the station on a ramp paralleling the passenger subway. It is taken to the platforms on elevators, each platform having an elevator at each end. Mail is handled in like fashion, but there are also two mail chutes in the north platform for carload lots. Express in small lots is handled similarly to baggage and mail but larger lots are loaded onto cars placed at the special express track to the south of the other ten. There are special express offices fronting on the street in the rear of the station.

The station's coach yard is on the northwest side. It has a capacity of about 175 cars and includes a warming house 200 ft. long and covering two tracks. A wheel pit is also provided. Along the end of the yard there is a service building two stories high containing quarters for the Pullman Company, the commissary department, car cleaners, etc.

The Rochester, N. Y., station of the New York Central serves a community of about 250,000. It is used by the main-line trains of the New York Central and by those of three branches. The station was opened on January 19, 1914, and replaced a station that had been in use over 31 years. A view of the exterior of the building is shown in Fig. 51; a view of the waiting room in Fig. 12, and a plan in Fig. 50.

The structure is placed on a triangular plot of ground and is of somewhat peculiar design. The main building is rectangular, 260 ft. long, 134 ft. wide and four stories high. It is set parallel to the street but at an angle to the tracks. The exterior finish is of sandstone up to the level of the second floor and of reddish-purple brick above with sandstone timmings. Entrance to the station is through the middle of three large archways on the front covered by a long marquise and reached by a driveway. One passes directly into the main waiting room which is 6 ft. below the level of the street, 90 ft. wide, 155 ft. long and 54 ft. high. It seats 440 people and is large for a station of this sort. Practically all the station facilities surround the waiting room. The men's smoking room with its free and pay toilets is on the front of the building with entrance from the waiting room at the corner to the left of the entrance. The women's room occupies a similar position on the right. The ticket offices occupy a very large area on the right of the waiting room and are very conveniently placed. The dining and lunch rooms with attendant facilities are on the left. The information desk and the parcel room are on the street side of the station on the right. The baggage room is directly opposite with the checking counter on the right of the entrance to the concourse and the main handling space in the outer part of the angle between the station building and the tracks.

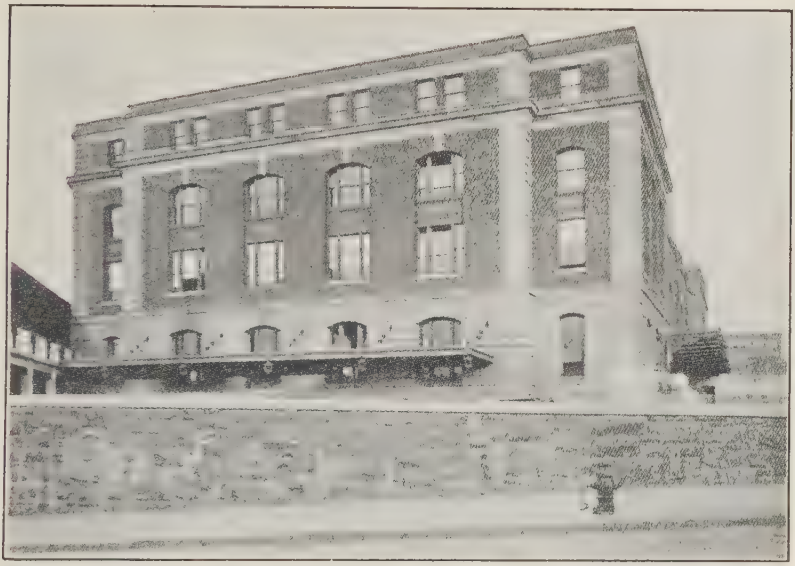


FIG. 51.—Exterior of Rochester Station.

The concourse is in the inner portion of this angle with an extension parallel to the tracks on each side of the subway to the platforms. There is a separate exit from the concourse to the street so that incoming passengers are not compelled to use the waiting room.

The station has 15 tracks. Four of these are used for through passenger and freight trains so that only six platforms are necessary. The platforms are 20 ft. wide at their widest part and have a maximum length of 1,200 ft. A subway 30 ft. wide and 8 ft. high connects the concourse with the stairways leading up to the platforms. It is arranged so that passengers can be held at the entrance to the concourse until the arrival of their trains.

The baggage room and the adjacent express room are provided with a separate driveway for teams. Baggage and express are trucked to the three westbound platforms on the further side of the station through a trucking subway 20 ft. wide and 9 ft. high connected with each platform

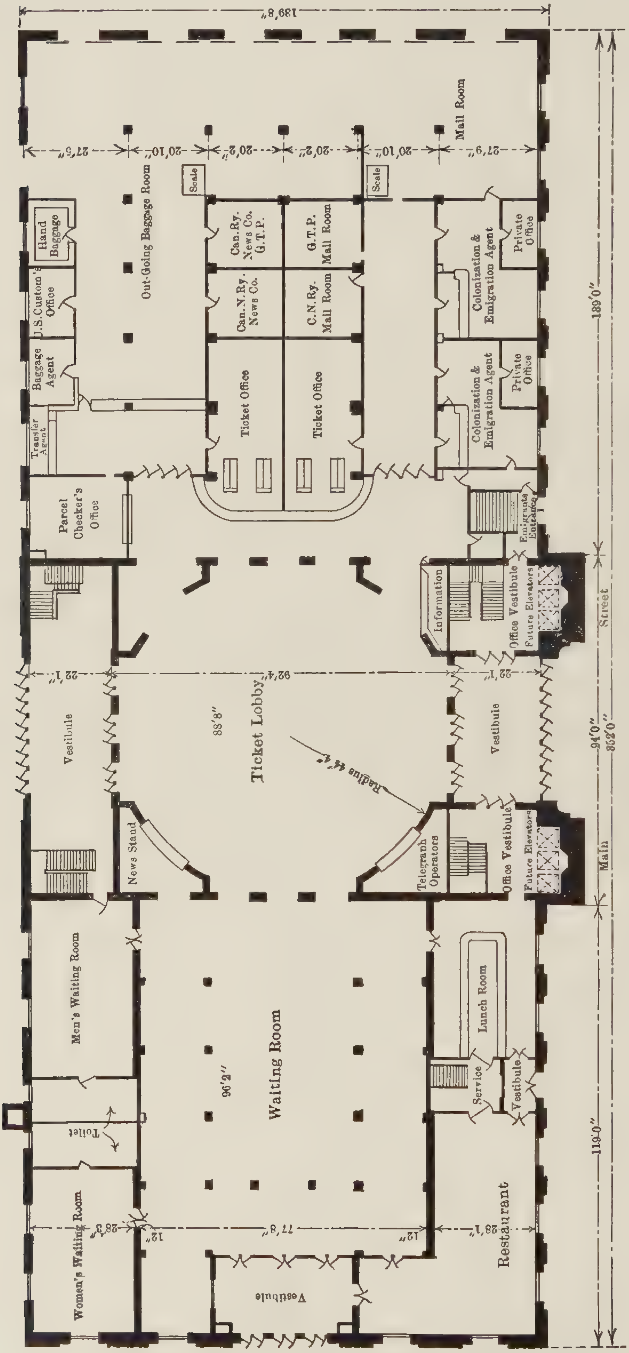


FIG. 52.—Floor plan of Fort Garry Station, Winnipeg.

by an elevator. The three eastbound tracks are reached by trucking across the tracks at grade from the second floor of the baggage and express rooms.

The Fort Garry station used at Winnipeg, Manitoba, by the Canadian Northern and Grand Trunk Pacific forms part of an extensive system of freight and passenger terminals. The entire layout is situated in a quadrilateral bounded by Main Street, Water Street, the Assiniboine River and the Red River. The station proper, a building 350 ft. long and 140 ft. wide, fronts on Main Street with its main entrance directly in line with Broadway. Behind it and included within the passenger station limits there are eight through passenger tracks, two freight running tracks and at one end of the layout three stub tracks containing 12 cars used for express loading, and four storage tracks also containing 12 cars. At the opposite end there are four other storage tracks holding 16 cars and two other tracks, one having a capacity of four cars for the handling of theatrical scenery and the other with a capacity of 11 cars being used for baggage. The freight terminal lies behind the station and is between it and the bank of the Red River. It contains two sets of sheds for handling house freight, each set consisting of a 40-ft. outbound shed, a 60-ft. inbound shed, a transfer platform and a set of six tracks. These houses are placed parallel to Water Street and the Assiniboine River. Parallel to these also there are 38 team tracks placed in sets of twos on 12- and 40-ft. centers and having a total capacity of 725 cars. Placed along the bank of the Red River and parallel to it there are also 10 supporting tracks holding 214 cars, four other team tracks with a capacity of 105 cars and seven storage tracks with a capacity of 140 cars. The approaches to all these tracks are in the form of two 2-track bridges, one over each of the two rivers and a 4-track bridge over the Assiniboine and a single-track bridge over the Red River.

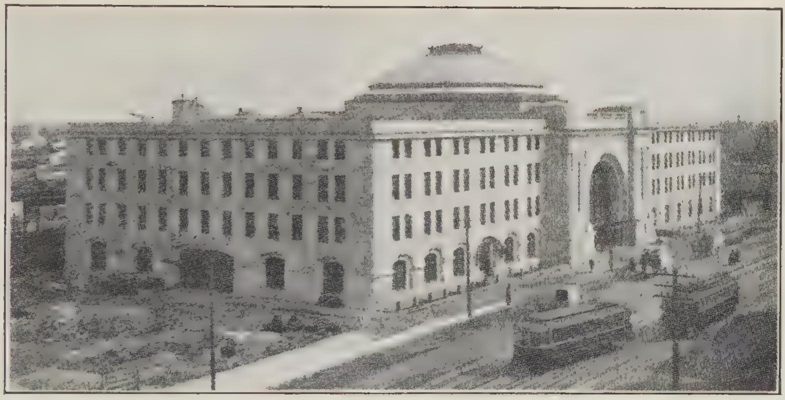


FIG. 53.—Station at Winnipeg.

The passenger station is four stories high, but provision has been made for the addition of four more stories if necessary. The remarkable feature is the ticket lobby approached from the street through a wide arched doorway and a large vestibule. This lobby is in the form of a circle, 90 ft. in diameter, entirely clear of columns, booths or seats, and surmounted by a dome 93 ft. in height. The ticket offices are placed just outside of it on the right as one enters and are readily accessible from it. The outgoing baggage room is placed beside them on the side toward the tracks and is therefore readily accessible from them. On the side toward the street and separated from the ticket offices by a wide passageway are two colonization and immigration agents' offices. A mail room occupies the portion of the station on the river side.

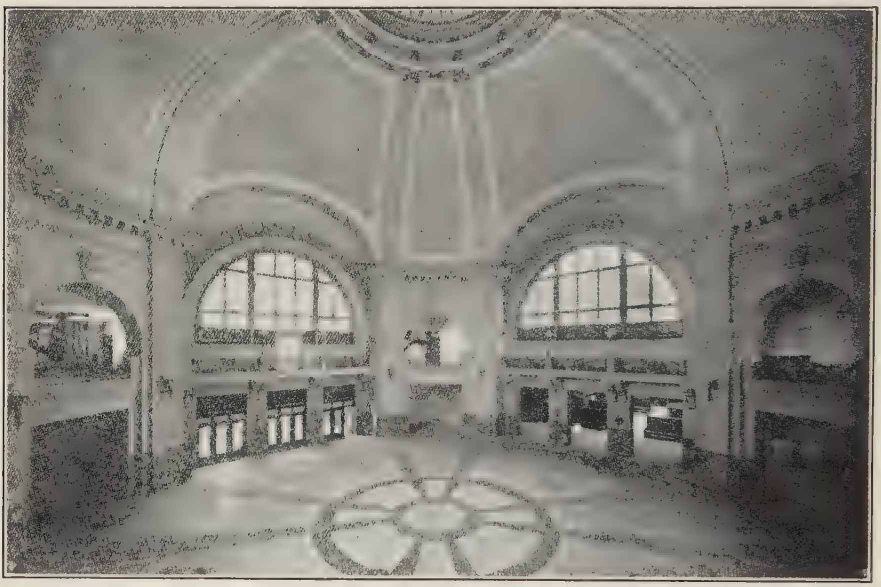


Fig. 54.—Ticket lobby of Winnipeg Station.

One also finds placed about the lobby the parcel check room closely adjacent to the baggage room, the information desk, a news stand and a telegraph office.

The waiting room is on the left hand side of the lobby as one faces the tracks and is of almost equal floor area. It can be reached through the lobby itself and also through a carriage entrance and vestibule fronting on a 50-ft. driveway on the north side of the station. On the street side of the waiting room there is a restaurant (2,200 sq. ft.), and a lunch room (1,300 sq. ft.), each having separate entrances from both waiting room and street. On the side toward the tracks are the women's waiting room, the men's waiting room and the toilets attached to each.

The through passenger tracks, as has been said, are eight in number. They have platforms 20 ft. wide and 1,650 ft. long. By the use of double crossovers, each is capable of handling two trains of 11 cars each during periods of heavy traffic. The total platform capacity is 200 70-ft. cars. The platforms are made of reinforced concrete and are 12 in. in height above the ties. The tracks themselves are 10 ft. above the level of the main floor of the station and therefore about the same distance above the street. The approach to them is through a vestibule and subway leading from the ticket lobby. The subway is 50 ft. wide and is connected with each platform by two stairways each 7 ft. wide. It is so provided, also, that passengers going to trains do not meet passengers coming from trains. The Bush train shed is used.

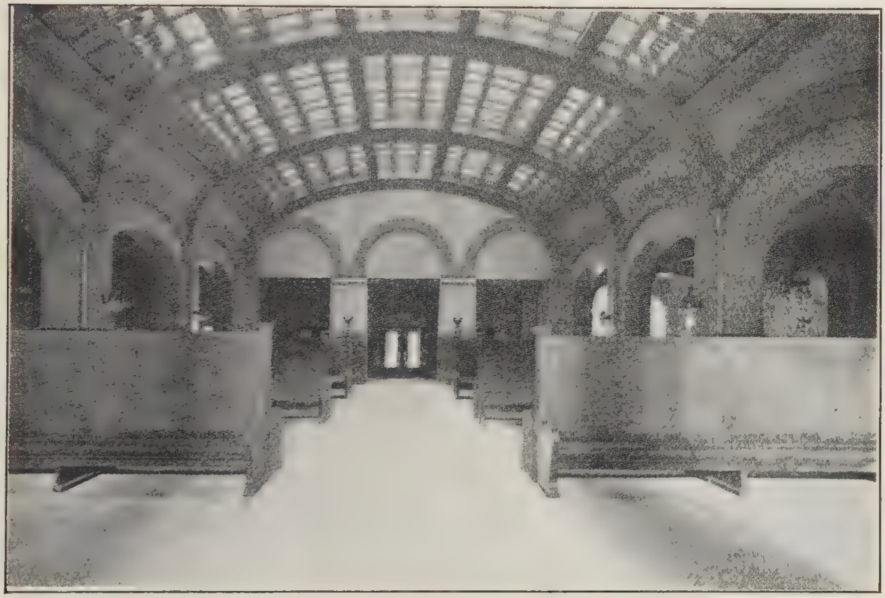


FIG. 55.—Winnipeg Station waiting room.

Underneath the tracks are placed the main baggage, express and mail rooms. These are approached from Main Street by a 50-ft. drive along the south of the building. The baggage room is on the north side of the driveway and beside it there is a mail room. There are two express rooms on the opposite side. Along side each of the driveway there is a platform 20 ft. wide connected by elevators with the train platforms above. Similar elevators are provided at the northern end of the station, trucking subways connecting these with those on the south side and the baggage room in the station itself.

The Oregon-Washington's new station at Spokane is part of a big system of passenger and freight terminals, costing approximately

$7,000,000. These terminals are, in turn, part of a project which included the construction of a new line from Spokane south to the Oregon-Washington at Ayer, 100 miles distant, on the south bank of the Snake River.

The passenger station building is 153 ft. wide, 300 ft. long and four stories high. The French Renaissance type of architecture has been

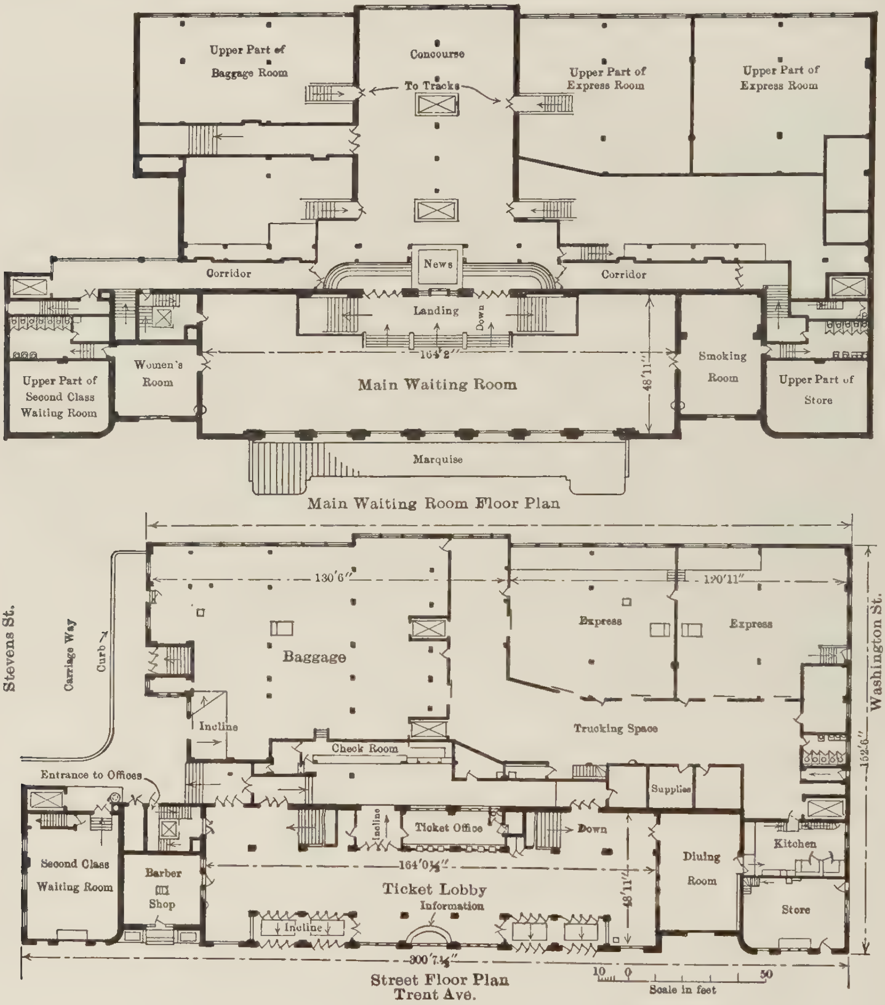


FIG. 56.—Plan of Oregon-Washington Station, Spokane.

followed. The main front up to the height of the first story is of cream-colored stone with a granite base. The main body above that is of tapestry or burlap brick. There are four large entrances protected by a marquise. These lead to the ticket and entrance lobby, 164 ft. long and

49 ft. wide. The ticket office is directly in front of the entrance. The baggage and express rooms are directly behind the ticket office, the check room being on the left and connected directly with its baggage room. On this floor are also a dining room, a barber shop and the lower part of the second class waiting room. The main waiting room is on the floor above. It is 164 ft. long, 49 ft. wide and 28 ft. high. At its right end there is an entrance to the men's smoking room, and on the left, one to the women's rest room. Directly behind the waiting room there is a concourse 100 ft. long and 54 ft. wide from which all the tracks may be reached by inclines and stairways. An exit to the space for carriages on the street level is provided for incoming passengers who do not wish to go to the waiting room. The remainder of the second floor is utilized for the upper parts of the immigrant waiting room and baggage and express rooms.

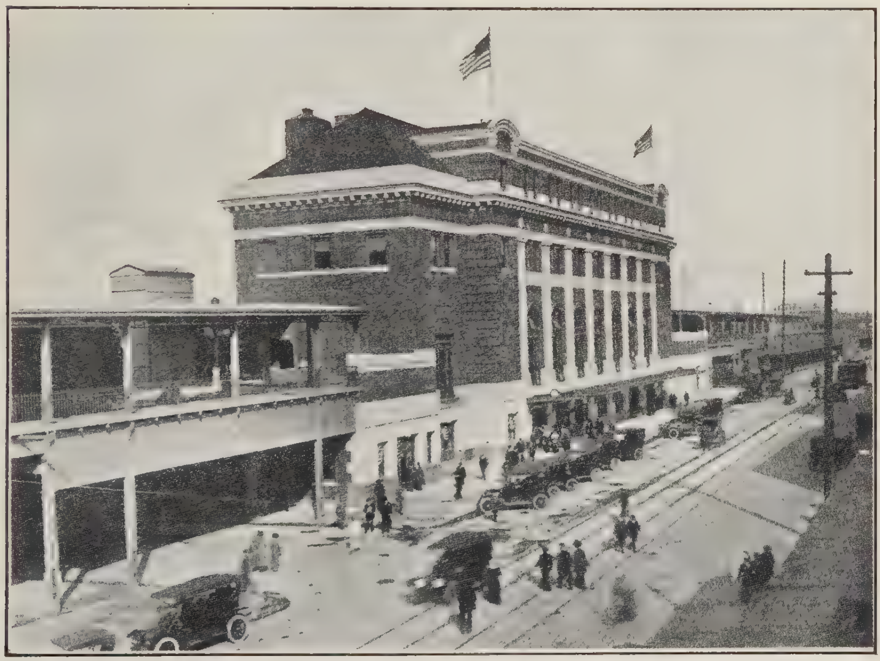


Fig. 57.—Exterior of Spokane Station.

The views in Figs. 58 to 60 are of the new Union Station in Worcester Mass. This station was part of a very extensive project of grade crossing elimination. It occupies a triangular plot facing on Front Street, at the west side of Washington Square only a very short distance from the business center of the city. The station's tracks are elevated. Those of the Boston & Albany, which owns the station, are on the south side while those of the New York, New Haven & Hartford and the Boston & Maine

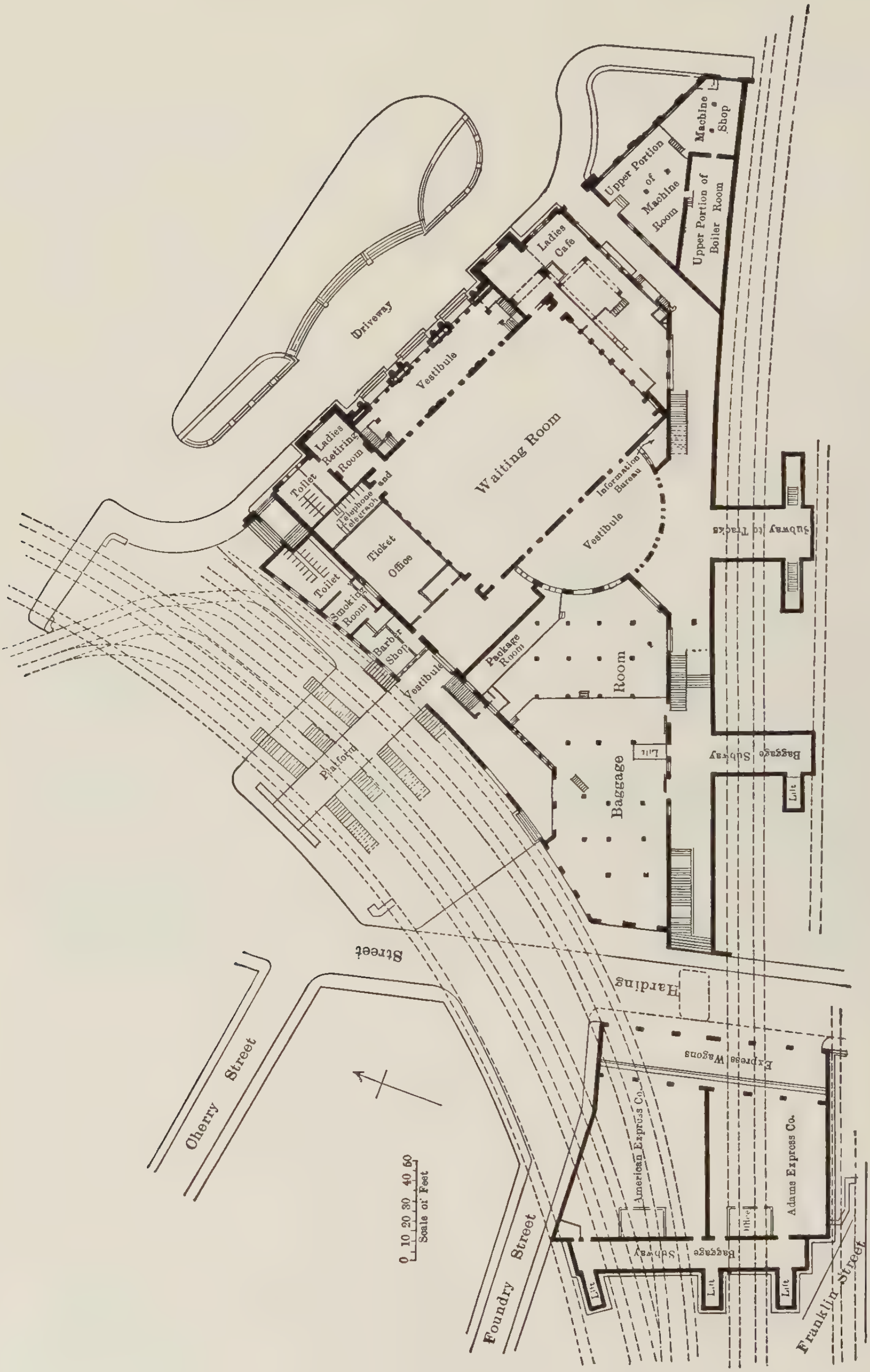


FIG. 58.—Track layout of Union Station at Worcester, Mass.

are on the northwest side and are approached from the north by a viaduct for trains of the latter road and from the west by the New Haven tracks running parallel to the Boston & Albany tracks and crossing them below grade at a point some distance from the station.

In the view of the main facade, the towers, which constitute the distinguishing feature of the station, are of white marble and extend 175 ft. above the level of the street. The three arches of the main entrance are buttressed by Ionic columns, and the marquise which hangs over the doors is 100 ft. long. The material below the marble of the towers is terra cotta and granite. On the front of each tower there is a balcony.

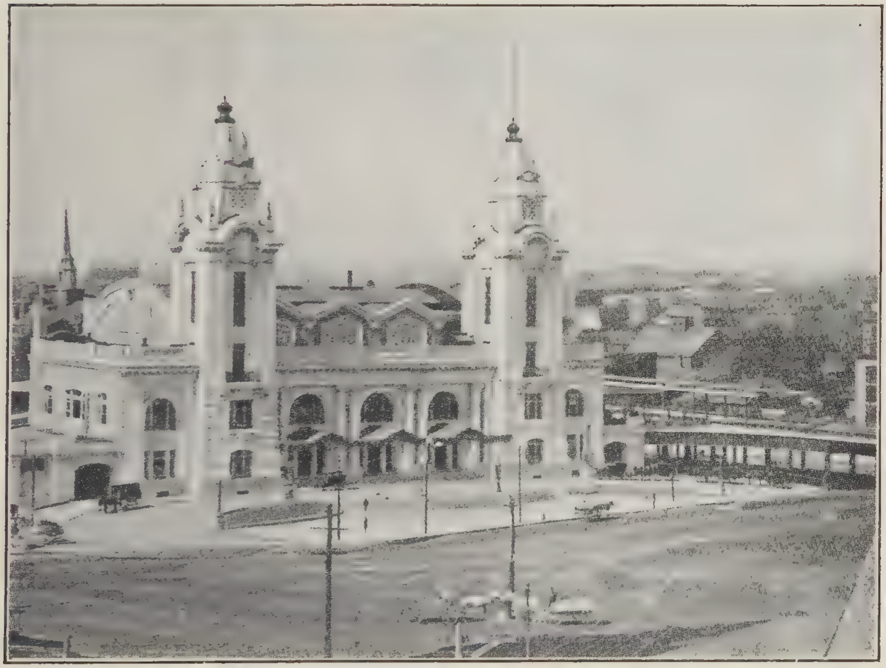


Fig. 59.—Exterior of Union Station, Worcester.

The main waiting room, shown in Fig. 60, is 128 ft. by 80 ft. The walls of the room are of soft-tinted caen stone[1] with a marble dado 4 ft. high. The columns at the doors are of marble. The view given is that seen by one facing the ticket office, which is 32 ft. by 52 ft. in size. The telephone booths and the women's retiring room are to the right, and to the left is the main exit to the viaduct tracks. The main entrance from the street is on the right-hand side of the room. It is in the form of a vestibule 100 ft. long and 20 ft. wide, this room having walls of cream-

[1] Caen stone is really a plaster preparation blocked to represent stone. It is of French origin, and it is a tradition of the trade that caen stone can only be properly made by a French plasterer drunk with absinthe.

colored brick, with a 7-ft. dado of Vermont marble. There are offices on the upper floor of the station.

The Boston & Albany has five tracks passing the station. Of these, three are used by passenger trains, one for westbound and two for eastbound trains. There is a fence between the first and second tracks and one platform suffices for both the second and third. As can be seen from the plan, persons coming from the station pass through a large semicircular vestibule and mount the stairs to train platforms. The Boston & Maine and the New York, New Haven & Hartford jointly have three through passenger tracks and two stub tracks, the platforms being reached by stairways connected with a subway and vestibule from the main waiting room.

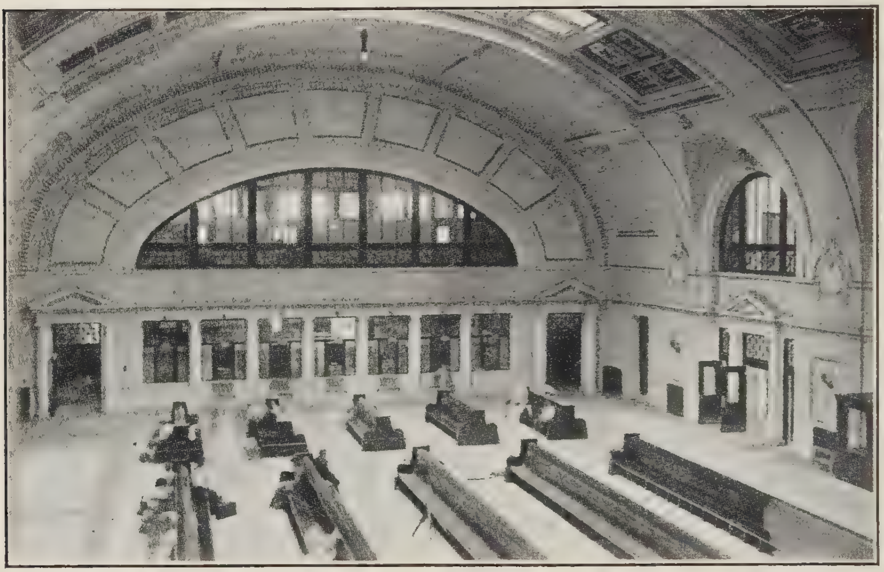


Fig. 60.—Waiting room, Union Station, Worcester.

The station's baggage room is in the southwest angle between the converging tracks. It is 175 ft. long and 100 ft. wide at its widest part. The express buildings are to the west. Baggage and express are carried to the upper level on elevators and the layout is such that trucks can readily pass from one train platform to another.

The remaining stations which we shall consider in this chapter are those of the third type in which the tracks are below the level of the streets. The Pennsylvania Terminal, which is easily the most important of all the terminals in this class, will not be considered at this point but will be left for Chap. VII.

The recently completed passenger terminal in Kansas City, Mo., is the property of the Kansas City Terminal Company, a corporation whose stock is owned equally by 12 roads which, with two companies subsidiary respectively to two of these roads, include all of the lines entering Kansas City.

The station is an unusual one. It handles practically no suburban traffic but the number of through passengers is out of all proportion to the size of the city. In 1911, 78,542 trains and 456,344 cars were handled for the 10 roads which used the former union station. Over 2,215,000 pieces of baggage were handled in the same station in 1911 and 2,076,084 in 1912. This combined with the amount handled at the other station made a total of 2,500,000, equal to the business of the South Station in Boston.

It is estimated that of those using the station, 30 per cent. are ticketed through and even that does not include those who may buy tickets locally to Kansas City and then to their destinations.

The transfer of mail is also very heavy because of the number of diverging routes. The proportion of mail transferred is so great that the Santa Fe finds it more advisable to set out one mail car and pick up another on its through trains and to transfer the mail going through, rather than the mail to be unloaded. About 225 to 300 tons of mail are handled daily, which compares very favorably with the 250 tons handled at the South Station in Boston.

The natural topography of Kansas City is so unfavorable for comprehensive railway development and the number of railways to be served so great that the construction of the passenger station was but part of an enormous scheme of freight and passenger terminal development the total cost of which was approximately $40,000,000. The station itself has a value of almost $11,000,000. It is situated near the center of the city and placed on high land beyond the reach of floods. It faces to the south on a large plaza covering two city blocks, purchased for this purpose by the terminal company. This plaza is on the level of the main floor of the station. The station is three stories in height above it and has a basement or track level with a sub-basement for express and baggage. The main building is "T"-shaped with a stem projecting out over the tricks. The head house is 510 ft. by 150 ft. while the portion over the tracks is 410 ft. by 165 ft. The building is of Bedford stone with granite trammings on the faces and bush hammered concrete in less important places. The exterior walls are of massive masonry, the Bedford stone being backed with brick, while the interior is of steel frame construction with reinforced concrete floors throughout. A view of the exterior will be found in Fig. 6, and one of the main waiting room in Fig. 8.

The main or plaza level is devoted to facilities for the public while the three upper floors over the end wings contain offices. There are two main entrances which lead from the plaza to the grand lobby in the center of the building. This room is 242 ft. long, 103 ft. wide and 92 ft. high.

It has three large arched windows facing on the plaza. With the exception of the ticket office which is located under the center window on the south side, this lobby is free of all obstruction. The lower portion is finished in Tennessee marble with Kasota marble above and is lighted by large electroliers suspended from the ceiling.

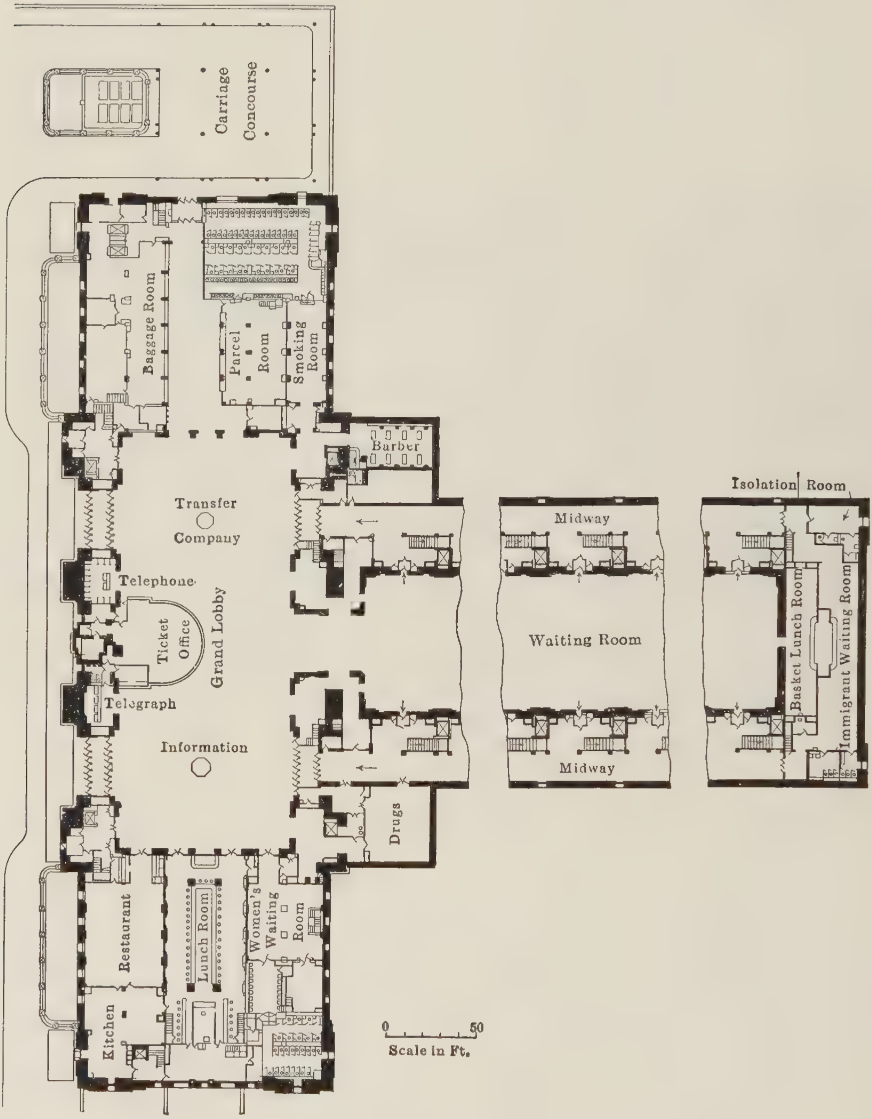


Fig. 61.—Floor plan of Union Station, Kansas City, Mo.

The main waiting room, 352 ft. long by 78 ft. wide, almost in the form of a concourse, leads directly from the grand lobby and extends out over the tracks. Gates leading to the different platforms are placed along each side of it and there are stairways and elevators from the midway outside the gates to the platforms below. As the midway also communicates directly with the lobby, incoming passengers may leave the station without entering the waiting room. The lunch room, restaurant and women's waiting room are placed in the east wing of the station. The baggage and parcel rooms are placed in the west wing on opposite sides of a passageway giving access to the lobby from the carriage concourse. The men's smoking room is behind the parcel room, but is entered from the lobby.

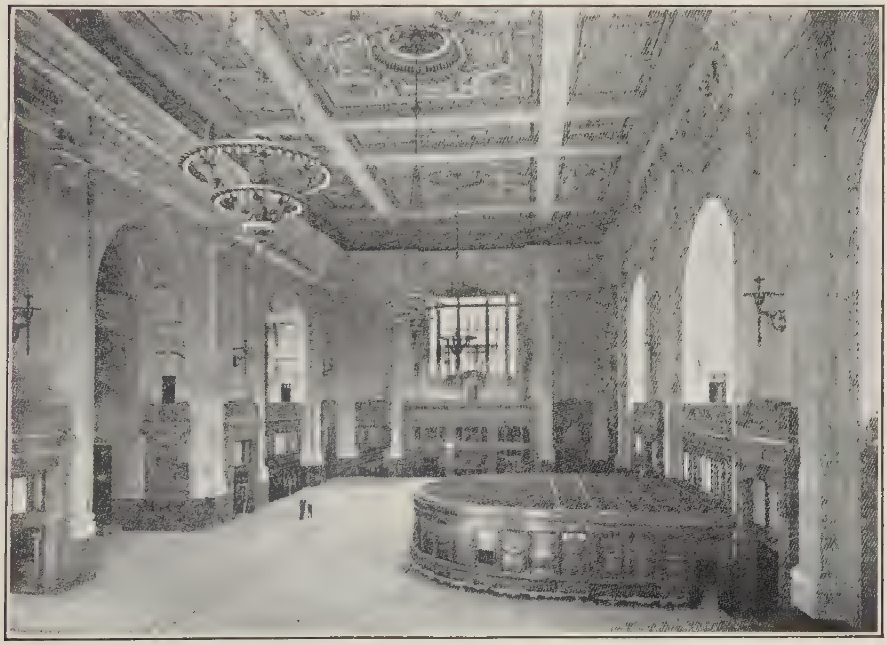


FIG. 62.—Ticket lobby of Kansas City Station.

The baggage and mail rooms are on the track level floor. Baggage and mail are received from a driveway under the plaza and are lowered to the sub-basement from which two tunnels pass under the tracks beyond the end of the station, with access to each platform. The express matter is also taken through these tunnels, and the sub-basement to the express building, a two-story structure, 1,000 ft. long and 60 ft. wide.

The station has 16 through passenger tracks. These are built in pairs, alternating 12.5 and 31.5 ft. center to center, with concrete platforms 8 in. above the top of the rail. Each pair of tracks will probably be provided with two crossovers, these being advisable because of the number of changes in train make-up that are made at this point. The train sheds used are of the umbrella type and are 1,370 ft. long. In addition to the through tracks, two stub tracks are provided at the east end of the station for mail cars, and eight similar tracks are built opposite the express rooms at the west end for express business. It is worthy of note that the layout of the station will permit of its extension over eight additional tracks if such additional capacity may be found necessary.

The new station of the Northern Central or the Pennsylvania Railroad in Baltimore is the only station with depressed tracks to have a Bush train shed. The station building is 60 ft. wide and 275 ft. long. It is classical in design. The exterior is finished in pink Milford granite. The waiting room, the most important part of the interior, is of Doric architecture and finished in Pantellic marble. There is also a concourse over the tracks which is lined with Faience tiling, and all the rooms in the basement are tiled. The building is four stories high, the upper two floors being used for offices.

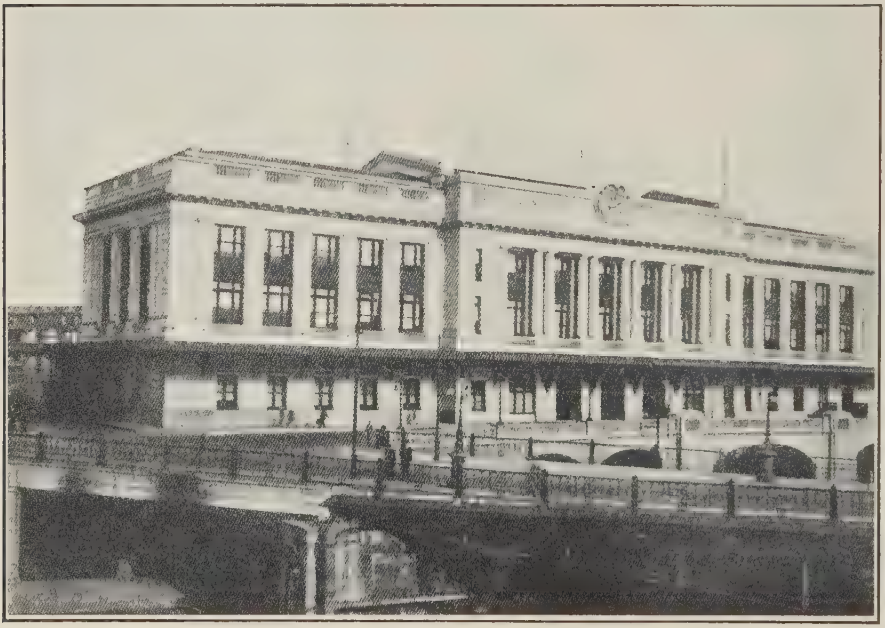


FIG. 63.—Northern Central Station, Baltimore.

The street floor contains the main waiting room, 65 ft. wide, 95 ft. long and 35 ft. high, the ceiling of which is of ornamental leaded glass. Adjoining are the ticket offices, telephone and telegraph offices, the news stand, retiring rooms for men and women, lunch and dining rooms, a parcel room and an upstairs baggage room for hand baggage only.

The train concourse is in two parts. One portion includes a covered lobby 330 ft. long and 28 ft. wide which extends along the track side of the station and connects with the Charles Street bridge, thus allowing passengers to go to and from trains without entering the building proper. The other portion consists of an enclosed lobby, 50 ft. wide, extending across the seven passenger tracks. This lobby opens into the main waiting room. The tracks are 18 ft. below the main floor of the station. There are eight stairways leading to the train platforms. These platforms are 20 ft. wide and from 600 to 1,000 ft. long.

The main baggage room, the express room, the station master's office, employees' lockers, dining rooms, Pullman commissary's rooms, kitchen and store rooms are all at track level. This level is reached by an inclined driveway parallel to the tracks, opening on St. Paul Street just south of and also parallel to the bridge connecting Charles and St. Paul Streets. A baggage chute and an elevator also connect the baggage room on the street level with the large room at track level. There are no subways under the tracks for handling baggage to the platforms. Baggage, therefore, has to be trucked across the tracks.

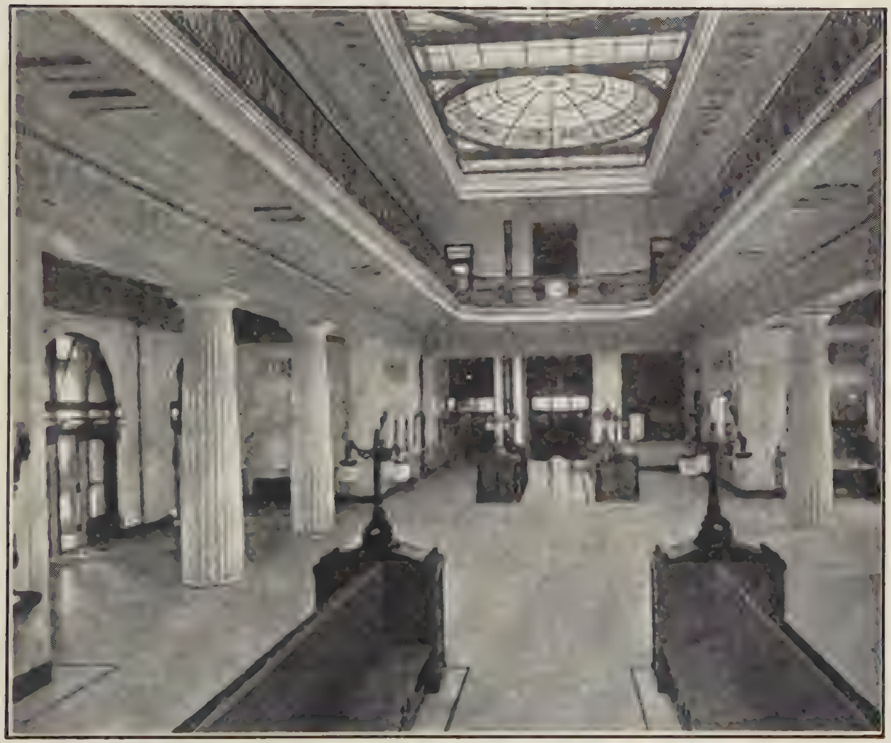


Fig. 64.—Waiting room of Baltimore Station.

The tracks of the Tacoma station of the Northern Pacific are 27 ft. below the street. The building, shown in the plan, Fig. 65, is about 106

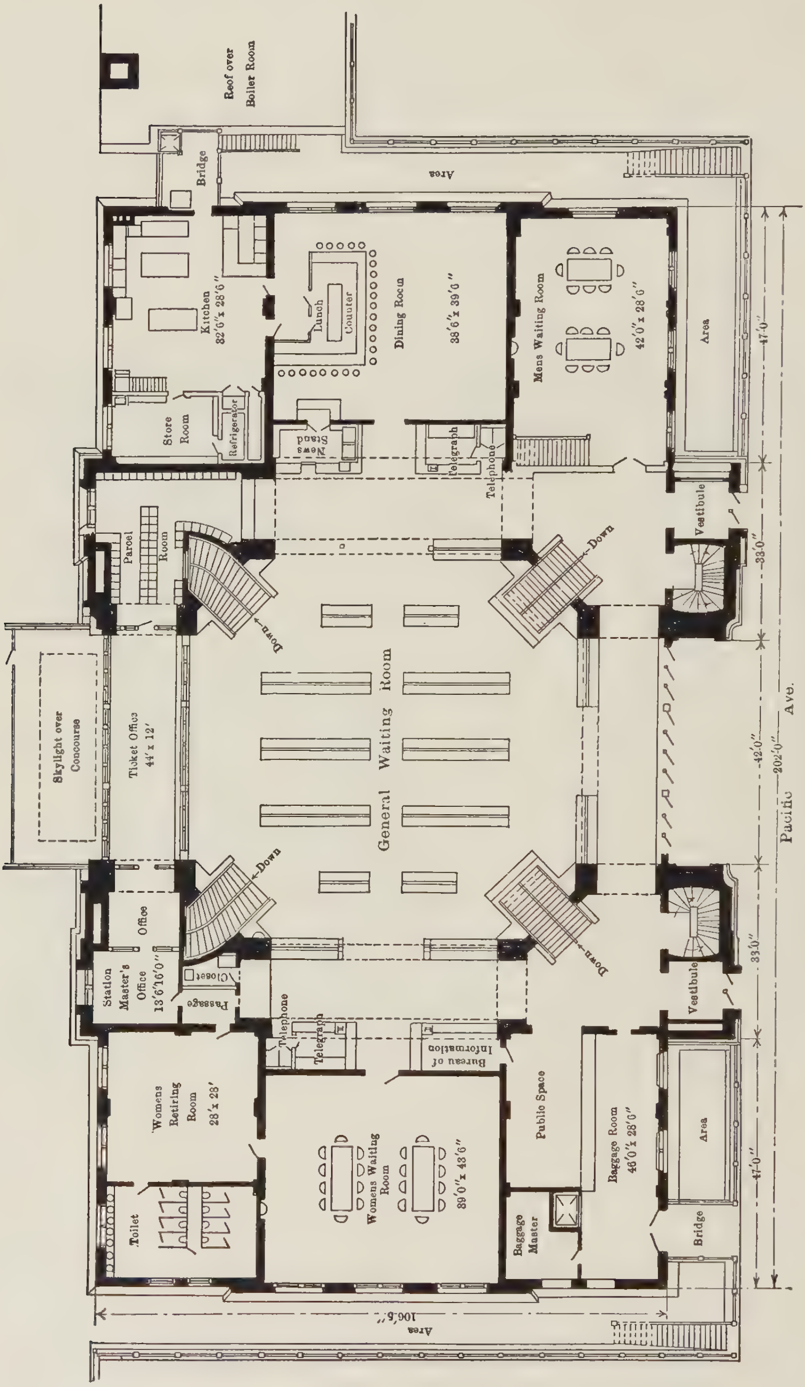


FIG. 65.—Plan of Northern Pacific Station, Tacoma, Wash.

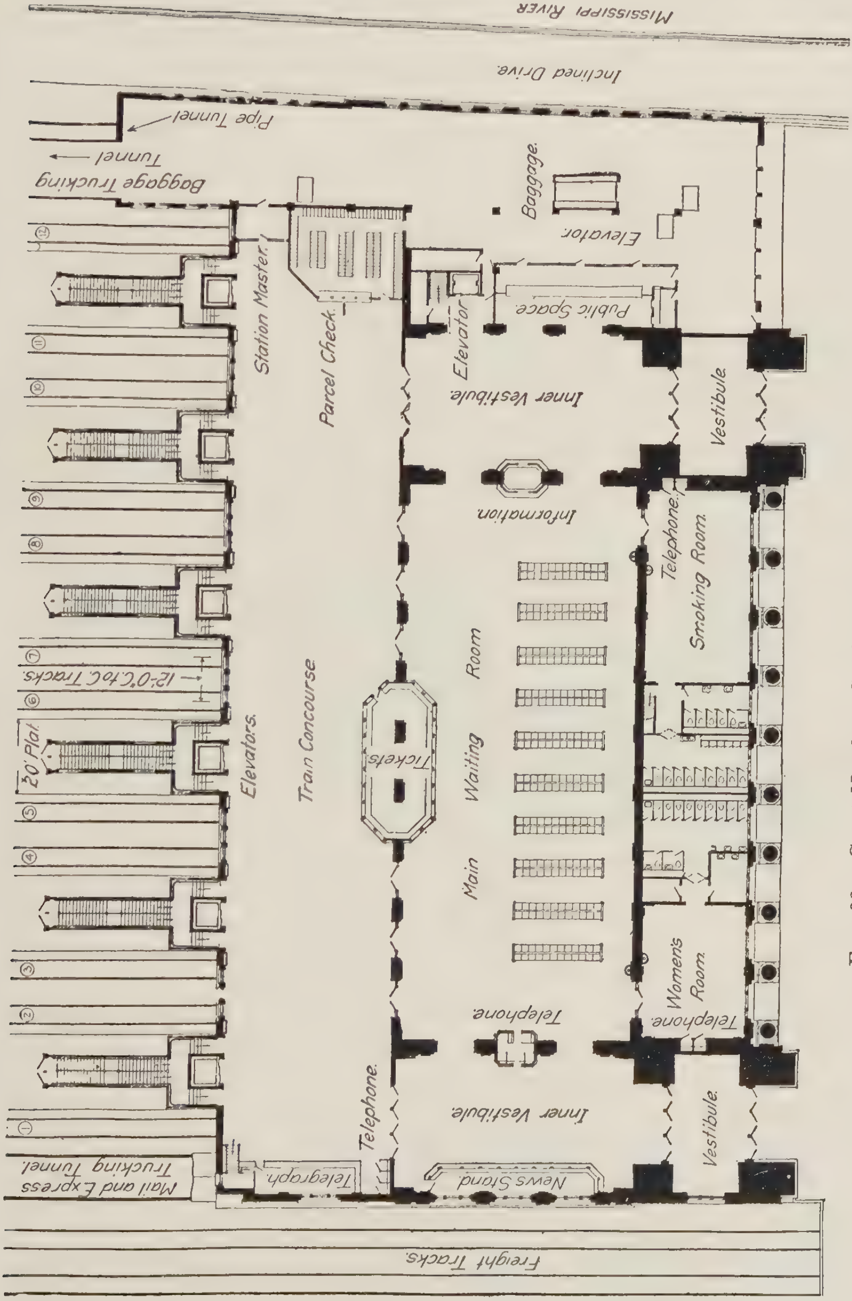


FIG. 66.—Great Northern Station at Minneapolis—floor plan.

by 200 ft. and is constructed entirely of steel and concrete with brick and stone walls above the street line and concrete below. The floors are of terrazzo with borders of marble and mosaic; and marble forms an important part of the wall treatment. Entrance to the station is through the large archway in the front. The general waiting room is directly in front of the entrance at street level. The concourse, however, is one floor below and has to be reached by the four staircases, one of which is at each corner of the waiting room. The tracks in turn are one level below the concourse but not directly underneath the waiting room. There are two flights of stairs from the concourse to each of the station platforms. The baggage, mail and express rooms are at track level under the concourse but there is a checking counter on the street floor connected with the lower room by an elevator.

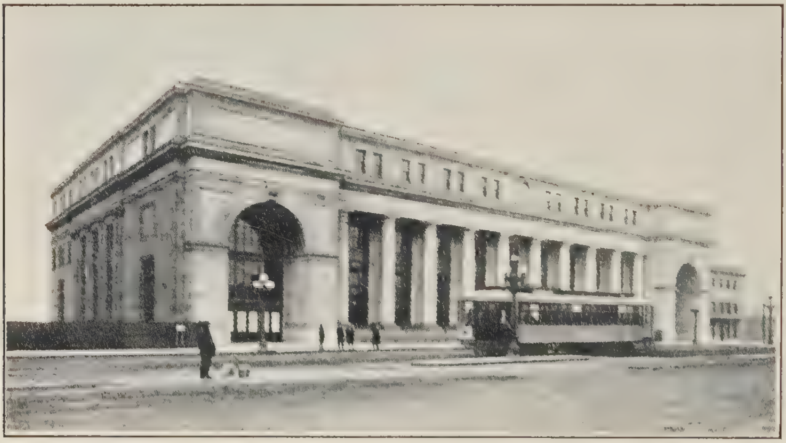


Fig. 67.—Exterior of Minneapolis Station of Great Northern.

The arrangement of facilities in the station could have been improved upon. That all persons using the station do not have to go through the waiting room is a good point. It is a detriment, however, that a person should have to cross the waiting room to get to the ticket office, retrace his steps to get to the baggage checking counter and then have to cover the distance still a third time by a walk through the waiting room or the concourse to get to his train.

The Great Northern station in Minneapolis was opened on January 22, 1914. It replaced a station built about 1885, and is used by the Northern Pacific, the Chicago, Burlington & Quincy, the Chicago Great Western, the Chicago, St. Paul, Minneapolis & Omaha and the Great Northern which owns it. It handles daily about 125 trains, 5,700 passengers and 1,700 pieces of baggage.

The station occupies a very advantageous position, for its main entrance fronts on the north side of the viaduct which carries Hennepin Avenue to the bridge by which it crosses the river. The tracks are thus placed along the river between the bank and the tracks of the Minneapolis Eastern which serves several of the city's flour mills. The station in turn is over the tracks on a level with the viaduct and so placed that its long dimension is parallel to the viaduct and, therefore, at right angles to the tracks.

The main building is 155 ft. wide, 300 ft. long and three stories high above the street. It is placed well back from the sidewalk, so that there is a clear width of street, including the sidewalk, of 150 ft. There is thus room for a cab stand in front of the station without interference with the cars and other street traffic. The building is a steel frame structure having brick walls faced with limestone.

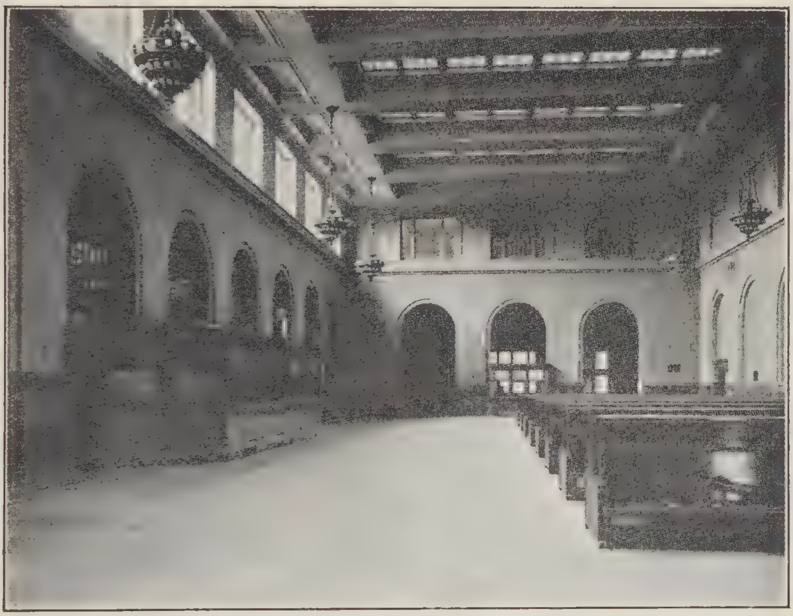


Fig. 68.—Waiting room of Minneapolis Station.

The main entrances are through two arches on the corners of the building facing Hennepin Avenue. These entrances lead to vestibules, 18 ft. by 37 ft., which in turn give access to inner vestibules, 37 ft. by 64 ft., the larger dimension being at right angles to the street. The waiting room lies between these two inner vestibules. It is 62 ft. wide, 150 ft. long, and will seat about 250 people.

Connected with it there is a men's smoking room with windows fronting on Hennepin Avenue, and with its only entrance on the extreme left end of the waiting room wall. The men's room has free and pay toilets and telephones adjacent to it and a barber shop on the mezzanine floor above entered from it. This compactness of facilities is truly commendable. The women's room occupies an analogous position on the other part of the front of the station.

The concourse lies beyond the waiting room and is 44 ft. wide and 265 ft. long. It can be entered through the waiting room but the majority of the passengers that use it can reach it through the vestibules without entering that room at all. It might be said too that the plans of the station included a scheme whereby two stairways will be built from the south side of the street directly to two platforms serving four tracks used by the Great Northern's Minnetonka suburban service.

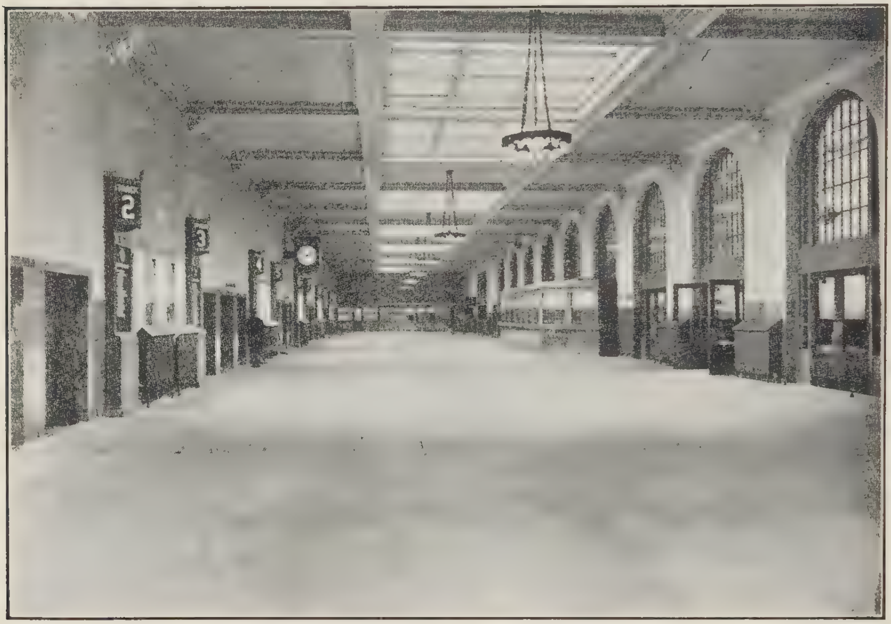


Fig. 69.—Concourse of Minneapolis Station.

The ticket offices are placed between the waiting room and the concourse and thus they further the plan whereby the waiting room is a facility for waiting passengers rather than a thoroughfare. The baggage check room is on the right-hand inner vestibule as one enters the station. Some retracing of steps is necessary for those who may desire to use it, but not enough to be a detriment. The parcel check room is closely adjacent on the concourse. The telegraph offices are likewise on the concourse.

There are 12 tracks, covered by a train shed of the butterfly type. The tracks are in pairs, 12 ft. on centers and the platforms are 20 ft. wide. As the tracks are at right angles to the station and its concourse, no subways are necessary. It is possible to go directly to any platform from the concourse. The gates are on the latter, therefore, and trains are announced by Hutchinson indicators (see Fig. 135) placed at each track. Stairways and elevators are provided to carry persons down to the platforms.

The baggage room 170 ft. long and 22 ft. wide occupies the east end of the station. As only local mail is handled, a small mail room in a building on the west side of the tracks south of the viaduct suffices. The express room, somewhat larger, occupies the remainder of the building. The baggage, mail or express is carried to trains on an elevated passageway 12 ft. wide at its narrowest portion connected with each end of each platform by an elevator. There are also three team tracks on the east side of the shed for carload lots of baggage or express, these tracks being reached by an inclined drive from the viaduct.

CHAPTER V

HEAD OR STUB STATIONS

The head or stub station is an end-of-the-line station, the tracks of which end at bumpers or in loops and in which the runs of the trains of a system or a division of a system terminate or are continued only after a reverse movement. Such stations are usually arranged so that passengers going to and from trains will not have to cross the tracks in any way, but that peculiarlity, while it is usual, is not necessary. The definition naturally includes water front terminals, but the latter have peculiarities that make it advisable to consider them in a separate chapter.

Most of the largest and busiest stations in this country are head stations. The latter are also the ones most frequently found in the largest cities. Thus, practically all the terminals in New York City are built on the stub station plan. The Pennsylvania Terminal at 33rd Street and Seventh Avenue, the leading side station in the country, is a marked exception. This station at present, however, does a purely head station business, although, to be sure, it is planned to run trains from New England to the South at some future time. In Chicago, exactly the same situation holds true. Every passenger terminal of importance in the city is a head station. Philadelphia is the third city of the country. The Pennsylvania Railroad's Broad Street Terminal and the Philadelphia & Reading Station in that city, both of them end of the line stations, rank with the busiest in the country. St. Louis, which ranks next in order, contains in the form of its Union Station, one of the largest passenger terminals in the world, and that is a stub station. Boston, the country's fifth city, likewise contains two of the busiest stations in the United States. Both of these are head stations. Part of San Francisco's passenger traffic uses a station at Oakland Pier which handles 1,000 trains a day. Naturally enough since that station is a water front terminal it is also a stub terminal.

In most of these terminals the traffic is predominatingly suburban to such a degree that one is led to wonder whether the head station has not peculiarities which make it better adapted for such traffic than the through station. It is hard to see wherein that could be. That each of the stations mentioned is so busy or that it handles so large an amount of suburban traffic lies primarily in the simple fact that it serves a busy city, or one in which, in addition, the railroad commutation traffic is of considerable volume. That it is a stub station depends mainly upon the character of the city in which it is placed. It may have happened in each instance that the predominating share of the traffic at the time the station was built was to or from the city rather than through it, and that there was, therefore, no great necessity for a through station. In other cases, of which Chicago may be considered typical, there has been a lack of coöperation. Each railroad brought its patrons to or took them from the city and since its trains did not run through could not see a necessity for a through station. The site available often makes a head station necessary. In the case of the Grand Central Station in New York, for example, the railroad's right of way is only a narrow strip of land extending through the center of Manhattan as far as 42nd Street. The use of that strip demanded and permitted nothing else than an end of the line layout.

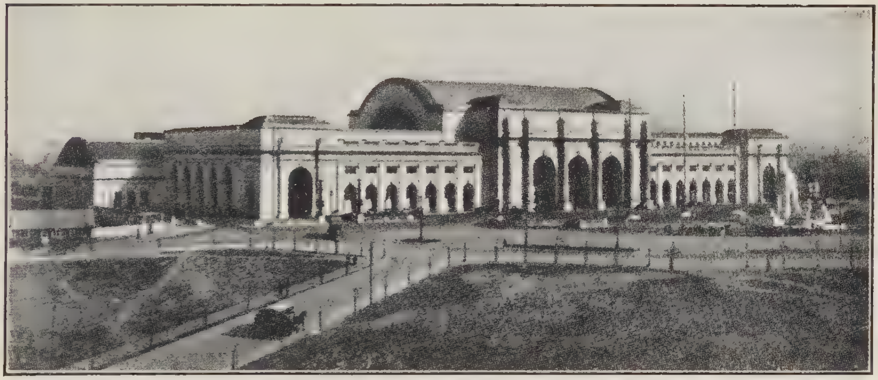


Fig. 70.—Union Station, Washington, D. C.

In recent years there has been a strong tendency away from the head station in favor of the side station. The inconvenience of reversing trains at a stub station so that they may continue their runs beyond it is one compelling factor. The other lies in the desire to facilitate the movement of passengers and trains through the city, a desire which if fulfilled will generally mean an increased amount of passenger traffic over the route through the city involved as against competitive routes through other cities and an increased share in the competitive traffic now already passing through the city itself. The Pennsylvania's New York Terminal at 7th Avenue and 33rd Street is the most noted example, as will be seen from its description in Chapter VII.

As in the case of through or side stations we may for convenience divide the head or stub stations into three general types:

(1) Tracks at or near the level of adjacent streets.

(2) Tracks below the level of the streets.

(3) Tracks above the level of the streets.

Stations of the first type are most common. Examples are to be found in the Union Station in St. Louis, the South Station in Boston and the various water front terminals about New York City. Stations of the second type include the leading head station in the world, the Grand Central Terminal in New York City. The best examples of the stations of the third type are the Pennsylvania's Broad Street Station and the Philadelphia & Reading Station in Philadelphia and the Chicago & North Western Station in Chicago.

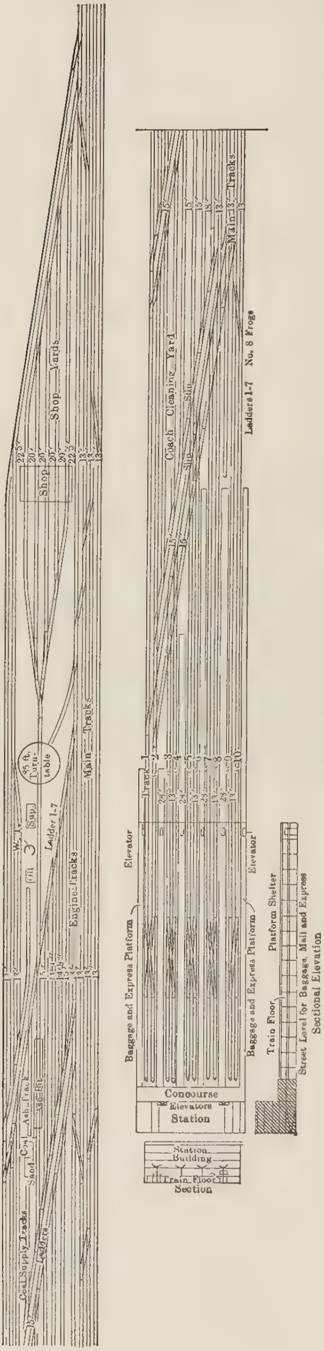


FIG. 71.—A. R. E. A. typical layout for head station.

In Fig. 71 is given a diagram prepared by the American Railway Engineering Association, showing the suggested or recommended layout for head stations, in which the double-track arrangement at the entrance is preserved to the greatest possible extent.

It is not generally known that Boston, Mass., contains the busiest and possibly the two busiest passenger terminals in the United States. These two stations are both head stations. Both are quite old and both are used to almost their full capacity. The South Station, by far the busier of the two, is probably the best example of the older type of head station to be found, and merits, therefore, a very thorough description. The North Station, on the other hand, was designed more or less as a makeshift. It is, however, of special interest to the operating man because some of the problems which have had to be solved in connection with it are quite remarkable.

The North Station in the fiscal year ending June 30, 1913, handled approximately 29,000,000 passengers, or about 7,000,000 more than the Grand Central Terminal in New York which is several times its size. The station is used exclusively by trains of the Boston & Maine and is, therefore, the busiest railroad terminal in this country used by a single company. The traffic, which is largely suburban, is mainly from the north and northeast of Boston, although there is also an important percentage of suburban and through trains from the west. The station is slightly more than 20 years old. It was built in 1893 and occupied on January 1, 1894. The structure when viewed in the light of modern ideals of terminal design has few claims to architectural beauty. The broad facade which at one time was held in high esteem has now been marred by an elevated structure built along its entire length. The station, although it was not necessarily intended to be such, was really built as an enlargement of the Boston & Lowell station which now stands almost intact as its southern end. That explains the duplication of many of the station's facilities such as the waiting rooms, toilets, etc. The structure, moreover, took the place of three older stations and of these the Boston & Lowell station was one.

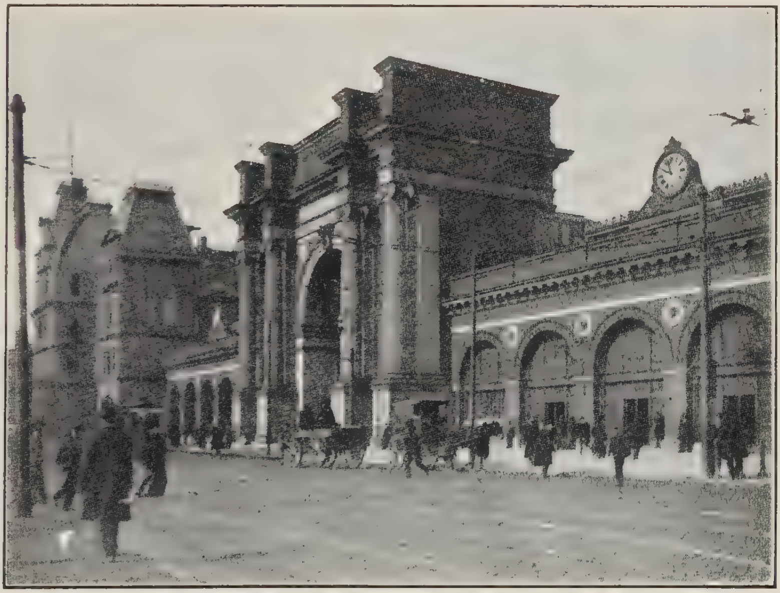


Fig. 72.—North Station, Boston.

The terminal occupies a most peculiar position. It fronts on Causeway Street which runs parallel to the Charles River and only a short distance from it. The result is that the entire station structure had to be supported on piles and the tracks out of the station laid on special trestle work built across the river to Charlestown. The draw bridges which have had to be provided produced with the peculiarities of the track layout over the trestle work a most difficult problem for a station management handling some 570 trains a day from the very first. The number is now 750 and they are well handled.

The facade is 586 ft. long and of this the old Lowell station makes up 205 ft. The main entrance is through an archway of cut granite 80 ft. wide and 70 ft. high, the arch itself being 30 ft. wide, 50 ft. high and 100 ft. long. To the left of the large arch there is a lower portion including the carriage concourse or cab stand 101 ft. by 108 ft. The waiting room is on the opposite side of the arch and is 98 ft. square. The ends of the station, are principally used for offices. The Lowell station, however, contains a station in itself on its ground floor, with its waiting room, toilets, etc. These facilities are used mainly by inbound passengers and their friends. This part of the structure also contains the inward baggage room. The office building at the opposite end of the station is three stories high and is not symmetrical in any way with the original station. Its front portion is a tower 45 ft. square. The remainder is in the shape of a long narrow building 318 ft. in length. The upper two floors are used for offices. The ground floor is devoted one-half to the outward baggage room and one-half to space for the express companies.

The train shed is 472 ft. wide and 540 ft. long. The older portion which is still extant has the usual old-time arched roof. The new part has a truss roof with nine spans, eight of which are 39 ft. wide. The shed covers 23 tracks. These, with the exception of one track in the middle of the station, are laid in pairs. The platforms are 18 ft. wide. They are granolithic and at the height of the top of the rails. At certain places the space between the rails is planked over and as there are no fences between the tracks, baggage trucks may easily be wheeled from one side of the station to the other. There are no trucking subways. The concourse behind the tracks extends the full width and is 50 ft. wide. It is separated from the platforms by a tall iron fence and there is an additional space between the latter and the bumpers, largely used by baggage trucks.

The station on the whole is quite convenient. The chief fault one has to find is that the waiting room is too much of a thoroughfare. It was not meant for such, however, and in that respect this old station can still serve as a model. The terminal is remarkably accessible. An observer can see that the city and its street railway company have tried to give its patrons the best of service. The fact is worth noting because it contrasts most strongly with the former situation that existed for a decade at the sister station.

The Boston South Station enjoyed for several years the distinction of being the largest and busiest railroad station in America. When it was new it was, in addition, considered the best designed and most convenient of all its contemporaries. It has since been eclipsed in some respects by various newer rivals but it has not lost its honor of being the busiest head station in the United States, for in the fiscal year ended June 30, 1913 it handled over 38,000,000 passengers, or 9,000,000 more than its nearest competitor, its sister station in Boston, and about 16,000,000 more than the Grand Central Terminal in New York, now the largest head station in the world. This enormous traffic arrives or leaves on trains of the New York, New Haven & Hartford from the south, southwest and southeast and the Boston & Albany from the west. These trains are mainly suburban, but they include a large number of busy runs between Boston and New York over the New Haven and Boston & Albany and between Boston and the West over the New York Central and its leased line, the Boston & Albany.

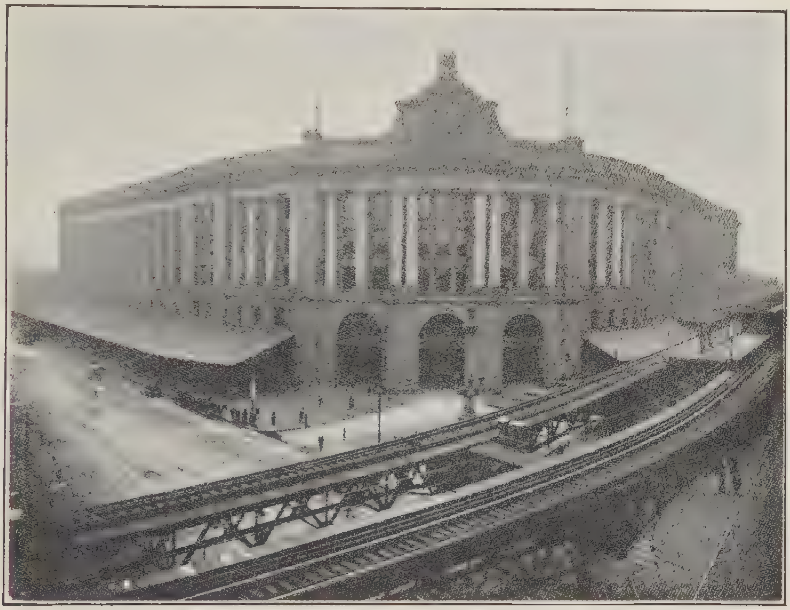


Fig. 73.—South Station, Boston.

The station is owned and operated by the Boston Terminal Company which was created for this express purpose with capital stock four-fifths owned by the New York, New Haven & Hartford and its allied companies and the remainder by the Boston & Albany. It was built in 1896, 1897 and 1898 and dedicated on December 30, 1898. It was first opened to trains of the Plymouth and Midland divisions of the New Haven on January 1, 1899; to trains of the Boston & Albany on July 23, 1899, and to those of the Providence division on September 10 of the same year. It replaced four older and smaller stations and its construction necessitated a complete readjustment of the streets about it. As its use also effected a decided change in the terminal situation in other ways the charter of the Terminal Company provided for the construction of two new side stations in Back Bay not far from the old Boston & Providence station in Park Square.

The station occupies a position to the south of Boston's business district separated by the width of a medium-sized street, Dorchester Avenue, from the Fort Point channel and parallel to it. The station buildings front on three streets, the most important part being in the form of a building five stories high, fronting on Atlantic Avenue and Summer Street with a very imposing front, made in the shape of the arc of a circle, facing on Dewey Square and including the main entrance. This five-story portion of the station has a total length of approximately 1,100 ft., 230 of which is included in the curved front, 320 of which fronts on Atlantic Avenue and the remainder on Summer Street. There is also a two-story continuation along the former street, 350 ft. long and a long narrow building, 50 ft. wide, extending 712 ft. beyond given over to the Adams and American Express Companies and the various local expresses that use the station. A section of the main building also fronts on Dorchester Avenue. The power plant and similar facilities are housed in a row of buildings extending along Dorchester Avenue in a similar position to that of the express building on the opposite side. These buildings, 570 ft. long and 40 ft. wide, house the heating system, the gas plant, the air compressors, the ice manufacturing and storage facilities, etc. The equipment provided for these is very complete.

The main entrance to the station is through a thoroughfare, 92 ft. wide, leading from the wide space in front of the station which faces on Dewey Square. The structure about this entrance is very imposing. It is faced with Stony Creek granite and included in its trimmings are several columns 40 in. in diameter. It is surmounted by a cornice with a top 97 ft. above the sidewalk and a parapet, 8 ft. above that. The most striking feature, however, is the clock, 14 ft. in diameter, placed directly in the center, 100 ft. above the street.

The arrangement of the facilities in the Boston South Station is rather unique. In some respects it is remarkably good, in others, bad.

The one exceptional point to be remembered about the station is that it was primarily designed to handle an enormous amount of suburban traffic. It being designed with that end in view, it is undoubtedly true that long distance travelers having to buy tickets and check baggage are somewhat inconvenienced. The main entrance is remarkably commodious and convenient. It leads directly to the midway or concourse so that patrons can go directly to their trains without obstruction of any kind. There is also a supplementary entrance from the street on the Atlantic Avenue side, and another adjacent to it from the elevated structure which runs along that avenue. The corridor which has the name of main exit leads directly from the concourse to Summer Street, but far fewer persons use it as an exit than those who leave by the more direct main entrance. The same holds true in a great degree of the carriage concourse at the corner of Dorchester Avenue. This space is 36 ft. wide and 180 ft. long so that it is of ample size. Nevertheless a very large proportion of the patrons of the station prefer to find their taxicabs at the entrance from the Atlantic Avenue side. The general waiting room is perhaps one of the most praiseworthy features of the station. It is 225 ft. long, 65 ft. wide and 28½ ft. high. It has a marble mosaic floor and its walls include a high dado with a polished granite base and plaster above. The high windows look out upon Summer Street, but the only entrance to the room is from the concourse and the so-called main exit. The room is entirely out of the line of travel from the street to the tracks. The passenger does not have to go out of his way to find it. It is provided on one side with a long row of parallel double high-back benches or seats. The only facilities that have to be reached through the waiting room are the women's toilet, the through and Pullman ticket offices and the information bureau, and all of these are so placed that persons using them do not in any way molest the waiting patrons. It must not be thought, however, that the various other station facilities are not within easy reach. The restaurant lies adjacent on the other side of the main exit. The lunch room which can be reached from either this exit or the concourse is 68 ft. by 73 ft. There is a dining room and an addition for the use of private parties on the second floor where are also placed the kitchen and bakery. On the

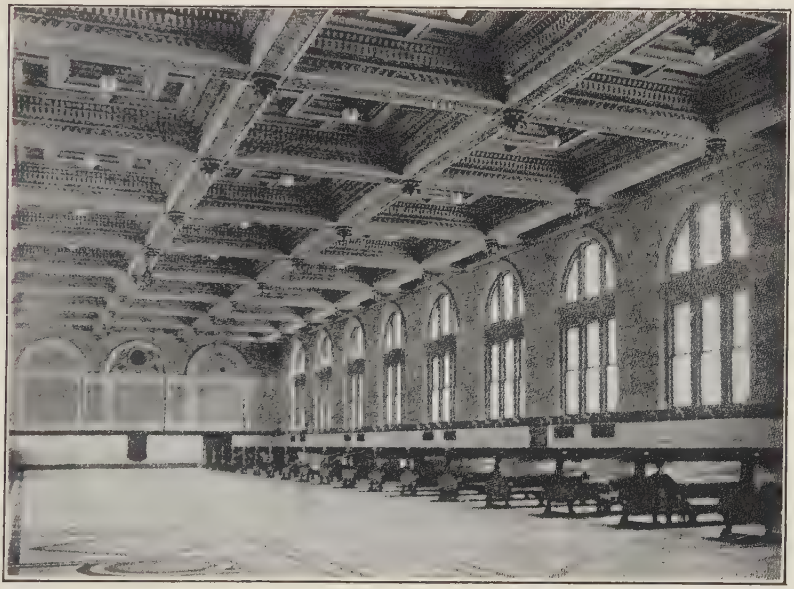


FIG. 74.—Waiting room of Boston South Station.

further side of the restaurant are two elevators to the offices. There is a barber shop adjacent to them in the rear. There are two sets of men's toilets. One of these is to be found on the north side of the concourse directly adjacent to the main entrance. The other is in the rear of the men's smoking room near the carriage concourse on Dorchester Avenue. The parcel room is on the right-hand side of the main entrance as one enters. It is 42 by 64 ft. and its windows front on the concourse.

The ticket office lies between the concourse and the general waiting room. It is 12 ft. wide, 92 ft. long, and has 27 windows, 16 of these opening on the waiting room and the remainder on the concourse. The former are mainly used for the sale of through and Pullman tickets. They also include one window set aside for the information bureau. The windows on the concourse are enclosed in a porch and are used mainly for the sale of local and commutation tickets. The local patron is thus exceedingly well provided for. The through passenger, however, is inconvenienced because he must come to the middle of the station to buy his ticket, retrace his steps to the outward baggage room on the west side of the station, check his baggage and then once more retrace his steps to get to his train on track 1, 13, etc., as the case may be. It has been estimated that on the average a person must cover 1,000 ft. in this manner, and that constitutes what is perhaps the most serious detriment to this terminal.

The station concourse is 600 ft. long and averages 100 ft. wide. The room has absolutely no claims to beauty, but is rather disfigured by a large number of signs directing one's attention to the various facilities. This, of course, is not absolutely necessary. It is, however, of considerable advantage to the traveler. The train shed (see Fig. 19) erected several years before the Bush type of shed was invented is an arched structure of three spans. It is of mammoth size, having a roof area of 710 ft. by 650 ft. and covers 28 tracks. These, with the exception of numbers 1 and 28, are arranged in pairs but there are 23 platforms, nine of which are used for baggage trucks only. These platforms are mostly of wood. They are no higher than the tops of the rails so that with the aid of three transverse trucking ways and the space between the bumpers and the gates they are made especially accessible as there are no fences between the tracks.

The baggage handling facilities at the South Station are especially extensive. The two baggage rooms opposite each other front on the street. The outward baggage room, 26 ft. wide, is on the Atlantic Avenue side and extends along it for 530 ft. The inward baggage room, in its turn, is also 26 ft. wide and fronts on Dorchester Avenue for a distance of 470 ft. Baggage trucks can reach the train platforms in various ways. They can use any of the three transverse trucking ways mentioned above from either of the two rooms. The station is also provided with an extensive system of trucking subways, one portion of which extends below the outward baggage and express rooms for almost their entire length and the other across the train shed as far as track 19. That it does not extend the entire width of the shed is due to the lower level arrangement described below. The trucks are lowered and raised between the track level and the tunnel by hydraulic lifts, 12 in number, including three leading to the lower level platforms and one provided to connect the inward baggage room with the storage room below it. The transverse trucking ways provide a means of connecting the elevators with the various station platforms at which there are no lifts, but it is rather unfortunate that so much baggage has to be carried along the narrow space between the concourse gates and the bumpers. The trucks seriously impede the lines of patrons going to their trains and are in addition a serious element of danger to them. Additional baggage and express facilities are also provided by the tracks and platforms placed behind the express buildings. Mail handling is similarly provided for.

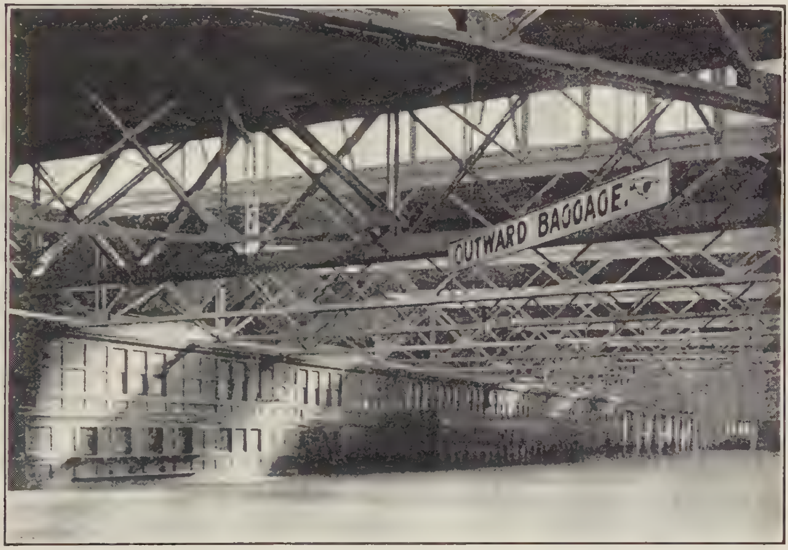


Fig. 75.—Midway of South Station.—Note signs pointing out location of ticket office and baggage room.

A great deal has been said about the great possibilities of the two loop tracks on the lower level of the station. It will practically suffice to say that these possibilities have not been realized and that it does not seem that they will be for many years to come. A glance at the plan in Fig. 76 will show the location and the general layout of the two tracks. The radius of the inner track is 242 ft., that of the outer 264 ft. They are designed for electric operation and preferably for multiple unit trains. The three loop platforms are long enough for 12 trains of three cars, that is six on each track. It was expected that there would be ample capacity for 2,000 trains in 18 hours or two each minute in the busy hours of the day. As things stand at present, however, it would seem that the idea of the lower level was a decided mistake. Not the least thing along that line is the fact that the road bed of the loop tracks is approximately 2 or 3 ft. below high tide, and that there had to be enormous expense for proper waterproofing. Nevertheless, the station was the first to have loop tracks provided in it. The idea has since been carried out with a marked degree of success in the Husdon Terminal in New York and the use of similar facilities is also planned for the Grand Central Terminal in the same city.

A glance at the plan of the Boston South Station in Fig. 76 will show one essentially weak detail of design in the arrangement of the track plans in front of the station. These are very elaborate, so much so that nine signal bridges and a tower containing an electro-pneumatic plant of 165 levers are required. As in many other large stations, however, too much dependence is placed on one set of switches and crossovers. A derailment in certain positions can practically tie up the whole plant and this seems too risky for a terminal handling about 850 train movements a day and almost 100 during the rush hour.

The magnificient Union Station in Washington is a splendid example of the city gate designed in perfect harmony with the architecture of the community for which it serves as entrance. The station was opened in 1907. It fronts on an enormous plaza at the junction of Massachusetts and Delaware Avenues and faces the Capitol about ½ mile distant. This site was selected only after very careful study and was the choice of a commission consisting of D. H. Burnham, C. F. McKim, Augustus St. Gaudens and Frederick Law Olmsted, Jr., which had been appointed to prepare a general plan for the beautifying and development of the city and its outlying parks.

The station is not a head station in the strict sense of the term, as several of its tracks descend to a lower level and pass through a tunnel to the east side of the station proper. It has been included in this chapter, however, because the larger part of its business is done on the stub tracks at the street level. The station is the property of the Washington Terminal Company whose stock is owned by the Pennsylvania and Baltimore & Ohio railroads. Four railroads from the south use the station in addition to the two owning roads, the six having formerly occupied two stations, the old Baltimore & Ohio terminal near the capitol and the old Potomac station near the corner of Pennsylvania Avenue and 6th Street where President Garfield was assassinated.

The station building proper, shown in Fig. 70, is 663 ft. long and 211 ft. wide and is built of white marble and granite. The three entrance

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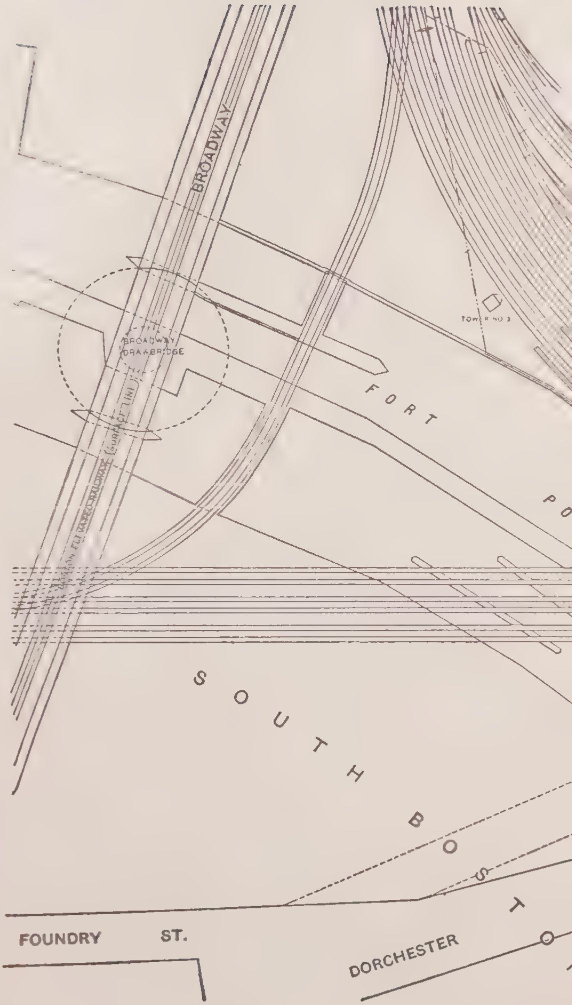

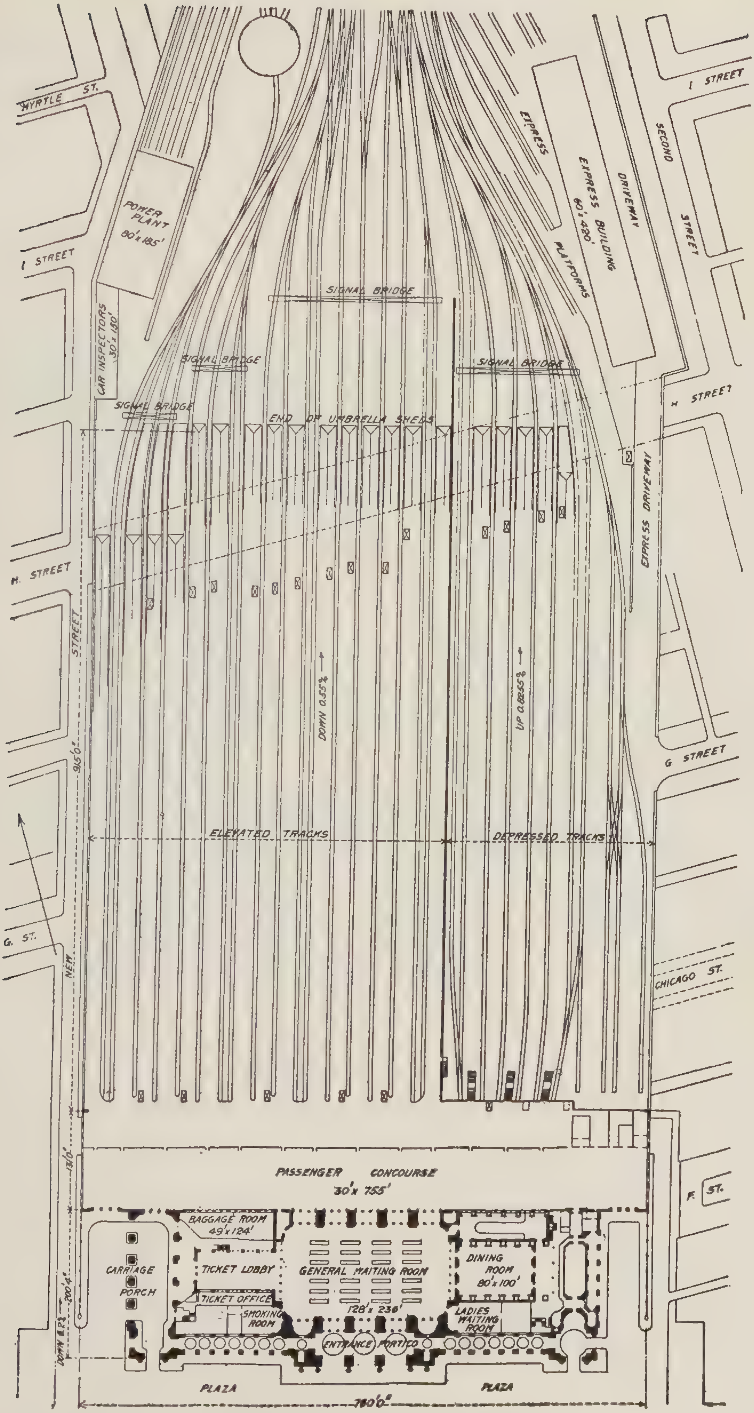

Fig. 77.—Plan of Union Station, Washington, D. C.

arches are 50 ft. high and lead into a vaulted open-air vestibule. The arches at the end are for carriages, one arch being for the use of officers of the government and leading to a suite of rooms for the exclusive use of the President of the United States and the guests of the nation. The general waiting room is 220 ft. long, 130 ft. wide and is covered by a Roman barrel-vaulted roof, 93 ft. high at its highest point. The concourse is perhaps the most remarkable thing about the station, for it is 760 ft. long and 130 ft. wide, covering an area of 97,500 sq. ft. The room is said to be the largest used for any purpose in the world and was given its enormous dimensions in order to be better able to take care of the great inaugural crowds every four years. The various station facilities are arranged on either side of the waiting room. The dining and lunch rooms and the women's retiring room are to the right as one enters and communicate directly with the waiting room, itself. The President's retiring room and the private reception room are also on the right, but they have a special entrance from the street. The ticket office and the baggage checking room face each other on a ticket lobby or passageway 50 ft. wide and 98 ft. long that leads from the left-hand side of the waiting room to the carriage concourse on the New Street side. The men's smoking room and a barber shop occupy a position behind the

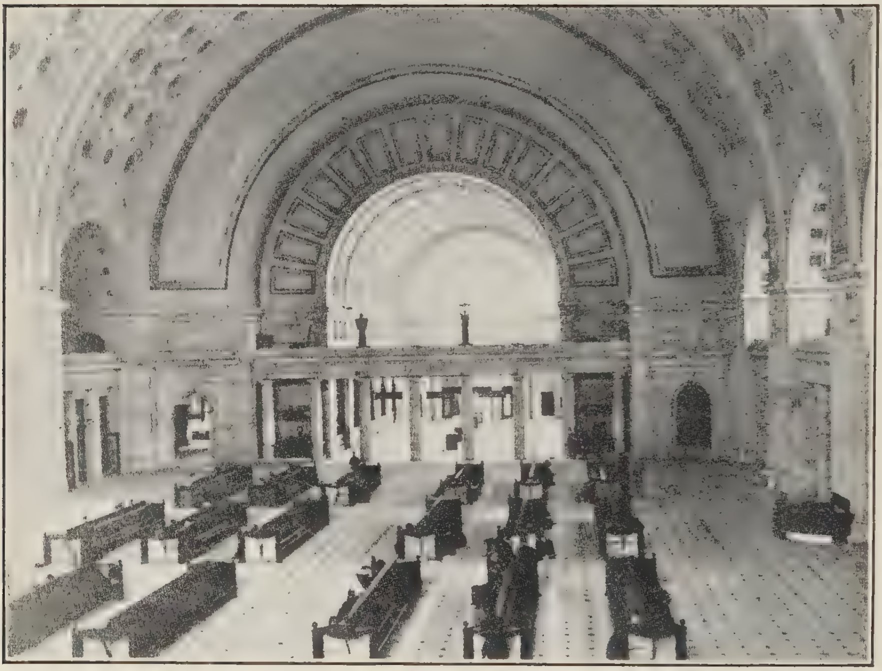

Fig. 78.—Waiting room of Washington Station.

ticket office and can be entered directly from the main waiting room. The station is also provided with an invalid's room, offices for a resident physician, a number of mortuary chambers, dressing-rooms with baths, a Turkish bath and a swimming pool.

The number of tracks in the station is 33, 20 of these being stub tracks on the upper or street level and the remainder through tracks on the lower level. The approach to the station from the north is by means of an eight-track masonry viaduct. On the south the through tracks converge into a double-track tunnel passing under Capitol Hill near the Congressional Library. Because of this arrangement, the stub tracks are on a 0.55 per cent. grade downward to the north and the through tracks on an 0.8255 per cent. grade in the opposite direction. The track platforms range from 700 to 900 ft. in length and are 20 ft. in width. They are made of concrete laid in cinders and faced with 1 in. of cement. All are reached directly from the concourse. The train shed is of the umbrella type.

The larger part of the basement of the station is devoted to the handling of baggage. Teaming space is provided at this level and such baggage as is checked in the baggage checking room is brought down on an elevator provided for that purpose. There are four trucking subways giving access to the train platforms. Two of these, 16 ft. wide, extend the whole length of the station. The other two are transverse subways; one, 60 ft. wide, is at the station end; the other, from 20 to 42 ft. wide, is at the other end of the platforms and gives connection with the express building, 420 ft. by 60 ft., which is beyond the northeast corner of the station.

The Chattanooga passenger station used by the Alabama Great Southern, the Central of Georgia, the Queen & Crescent and the Southern is a type of the essentially useful, straightforward, cleancut structure, easy and economical of maintenance with no waste space and no attempt at extravagance of any kind, either of ornamentation or color. The most striking feature of the structure's exterior is the facade and main entrance. This leads directly into the main waiting room about which the various facilities are arranged in convenient fashion. The main waiting room itself is 62 by 82 ft. The general dimensions of the other important rooms are as follows: men's smoking room 34 by 42 ft., ladies' retiring room, 26 by 40 ft., lunch room, 24 by 72 ft., dining room, 38 by 42 ft. and the ticket office, 21 by 40 ft. As usual in southern stations, there are separate rooms for negroes. The baggage room is 60 by 80 ft. and the mail room, 48 by 75 ft. The concourse is 60 ft. by 300 ft. To facilitate the movement of trains within the yards of the station and to allow all trains to back into the station, the double main track leads are arranged on a Y about 1,800 ft. east of the concourse of the main building.

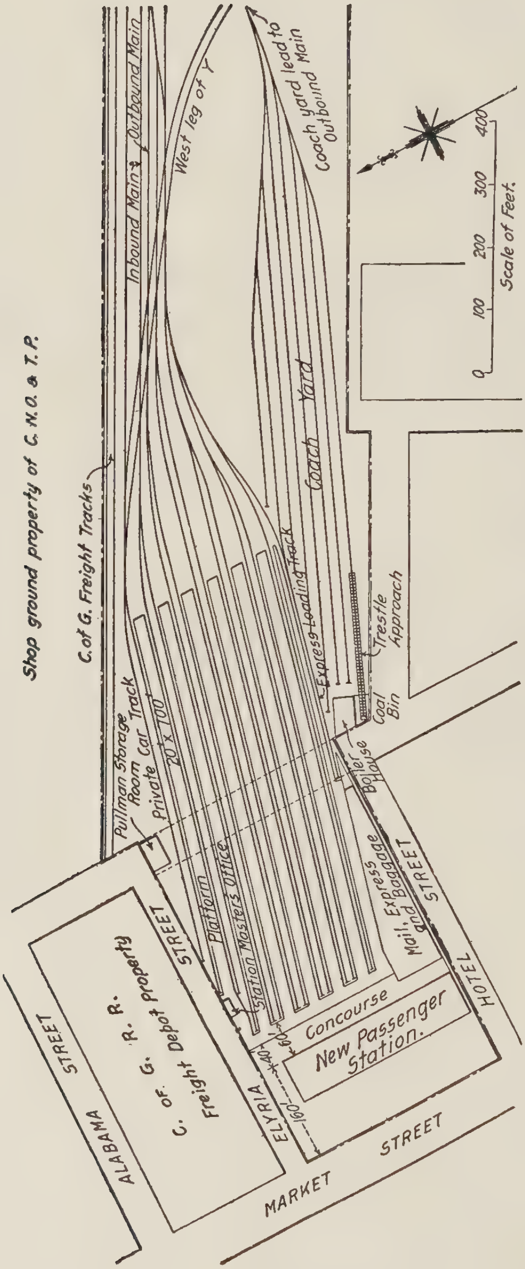

Fig. 79.—Layout of Chattanooga Station.

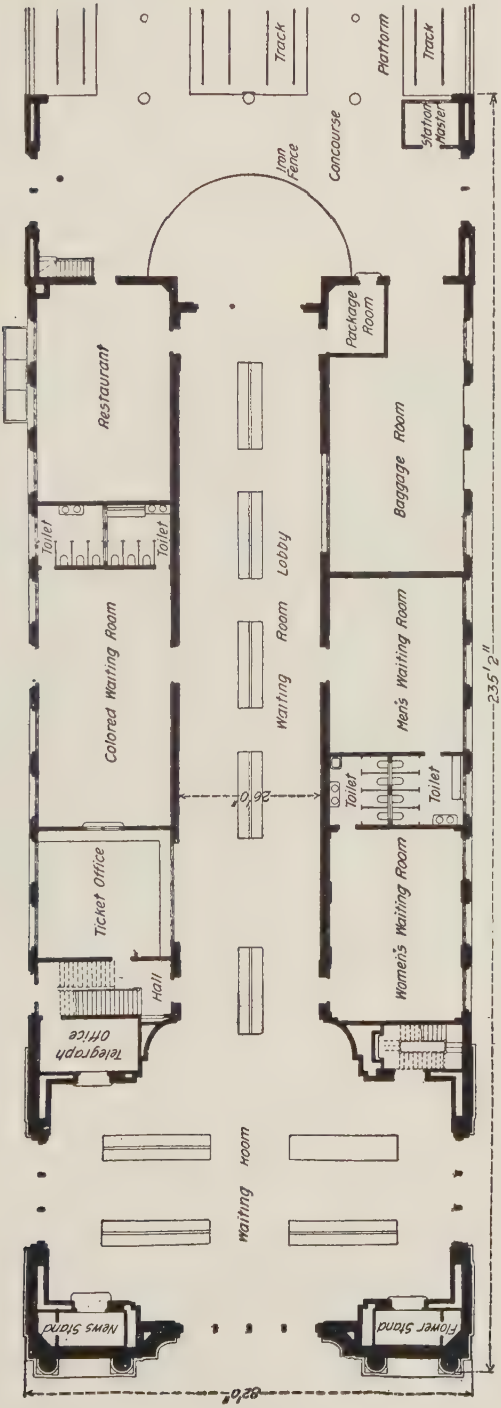

FIG. 80.—Plan of New Orleans Union Station.

There are 14 tracks entering the station. There is also an eight-track coach yard south of these tracks with storage capacity for 65 coaches.

These six concrete and granolithic platforms, 700 ft. long and 20 ft. wide, are covered by individual sheds of the butterfly type. There is also a platform in front for mail, express and baggage departments at the east end of the passenger sheds. The west leg of the Y runs through to the north side of the platforms and forms a ladder track with a series of single and double slip switches from which a train may reach any track leading into the station.

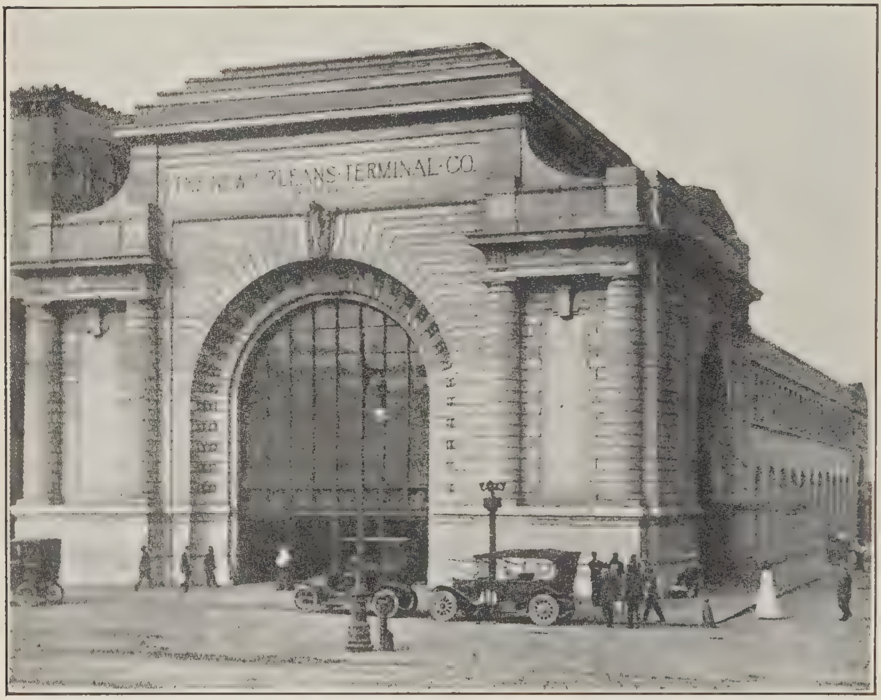

Fig. 81.—Exterior view of New Orleans Station.

An interesting and typical head station of medium size and pleasing architecture and interior arrangement is to be found in the Union Station of the New Orleans Terminal Company, which was built in 1908. A photograph in Fig. 81 is an exterior front and side view. The plan is shown in Fig. 80. The building is 82 ft. wide and 235 ft. long. The front portion, containing the main waiting room and the three large entrance archways, has an exterior of Bedford stone with a granite base. The remainder of the building is finished in brick and stone, the brick being special gray color to match the Bedford stone. As can be seen by the plan, the principal entrance is through the large archway directly on the front. This is 30 ft. wide and 40 ft. high. The two archways on the sides are each 30 ft. high. All three give direct access to the main waiting room, which, although it is 80 ft. long, 40 ft. wide and 52 ft. high, is really a large vestibule. The central portion of the building contains a lobby, 26½ ft. wide, which is a continuation of the main waiting room, extending from the latter to the train concourse. It is provided with seats and the various station facilities are arranged along its sides. These include the ticket office, the women's waiting room, the men's waiting room. the baggage room, the restaurant and the separate colored waiting room. These are all to be entered from the lobby but the colored waiting room is also accessible from the street. The second story over this portion of the building is arranged for offices. The concourse is 80 ft. long and 35 ft. wide. It has two large doorways, each protected by a marquise, leading to the street at each end so that incoming passengers can go directly to the sidewalk and to their carriages without having to pass through the station. The station has but four tracks. These are separated from the street by ornamental wire fencing and are protected by sheds of the butterfly type, each 470 ft. long.

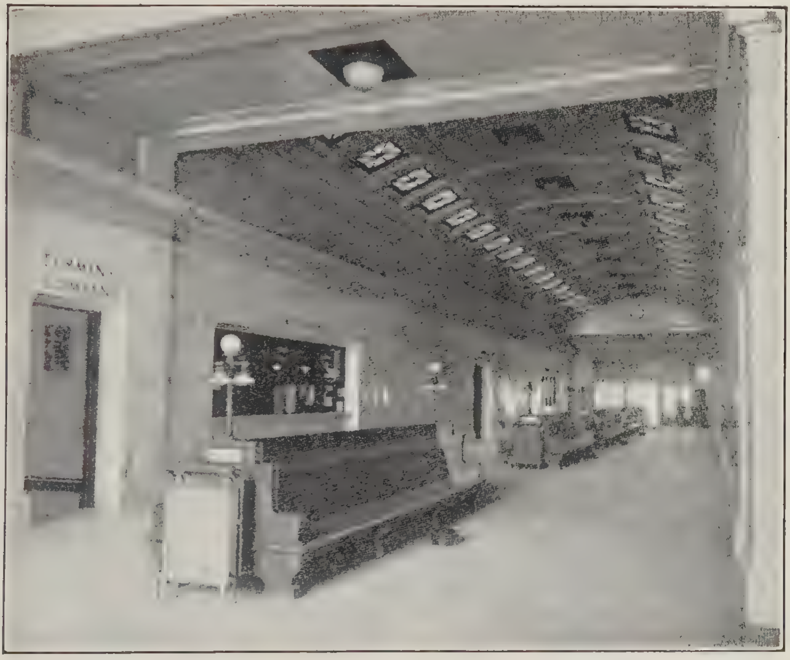

Fig. 82.—Waiting room of New Orleans Station.

The Oregon-Washington's station in Seattle, built in 1910, is one of the few head stations of this country whose tracks are depressed. The main floor plan of the station is shown in Fig. 83, the exterior in Fig. 84 and the waiting room in Fig. 85. The general waiting room extends through the

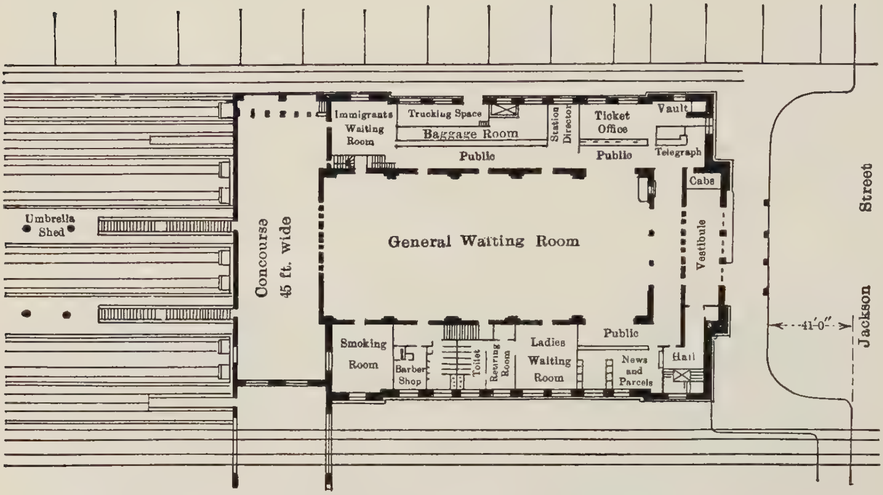

Fig. 83.—Main floor plan of Oregon-Washington Station, Seattle.

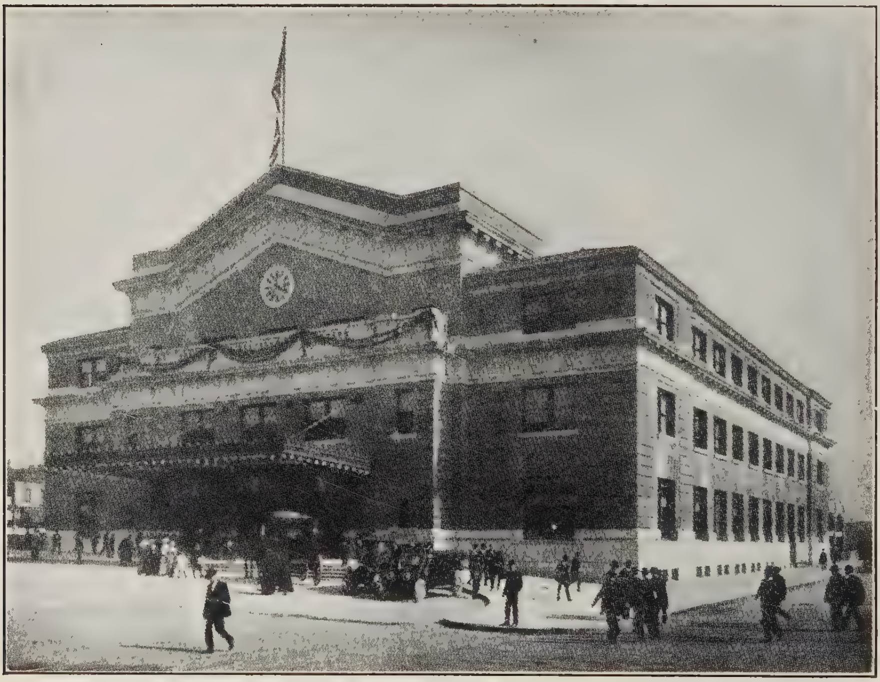

Fig. 84.—Exterior of Oregon-Washington Station, Seattle

center, the entire length of the street floor. It is 74 ft. wide and opens directly from the street through a small vestibule. The various station facilities all lead from the waiting room and their arrangement is most convenient. The concourse in the rear of the building is at the street level. It is 40 ft. wide and extends over all the tracks. It is provided with an exit from the general waiting room and in addition opens from the street on both ends so that incoming passengers may leave directly. The track level is 24 ft. below the street. Easy flights of stairs connect the concourse with the platforms. The latter are provided with umbrella sheds. Baggage is handled in the baggage room on the street floor and also on the mezzanine above with which it is connected by an elevator. It is also to be noted that there is a 3.84 per cent. incline leading from the street level at Seattle Boulevard to the track level and connecting with the teaming space along the tracks under the street. By means of this express and baggage may be transferred directly between the concourse and the wagons.

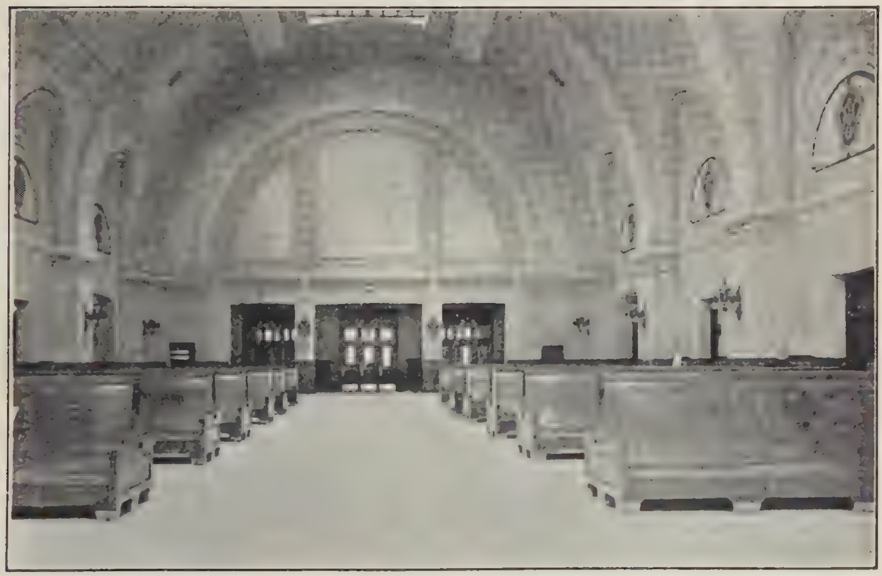

FIG. 85.—Main waiting room, Seattle Station.

An artistic building combining many good features is that of the St. Louis Union station. A view of the building, a track plan and a picture of the main waiting room are shown in Figs. 86 to 88. This station was opened for traffic on September 1, 1894, and was rearranged to take care of the large crowd attending the St. Louis Exposition in 1903–1904. The station proper is 80 by 606 ft., the midway is 70 by 606 ft. and the train shed is 81 by 601 ft. There are 32 tracks in the train shed, having a total length of 6.5 miles and a capacity of 330 80-ft. coaches. The station buildings themselves cover 13.25 acres. The area covered by all the buildings and grounds is 33 acres, or, including storage yards and connections, 73 acres. The entire system contains 39.3 miles of track with storage capacity for 1,064 coaches. The station's baggage room is 30 ft. by 300 ft. Access from it to the station platforms is provided by means of a subway system for the handling of baggage, mail and express, including a main subway, 601 ft. long and 100 ft. wide, and six connecting subways to adjacent buildings. There are also 35 hydraulic elevators which transfer baggage from the 32 tracks across the main subway to the teams below. In 1903 these facilities handled 1,454,675 pieces of baggage and in 1904 2,387,545[1]. About 290 trains are handled daily

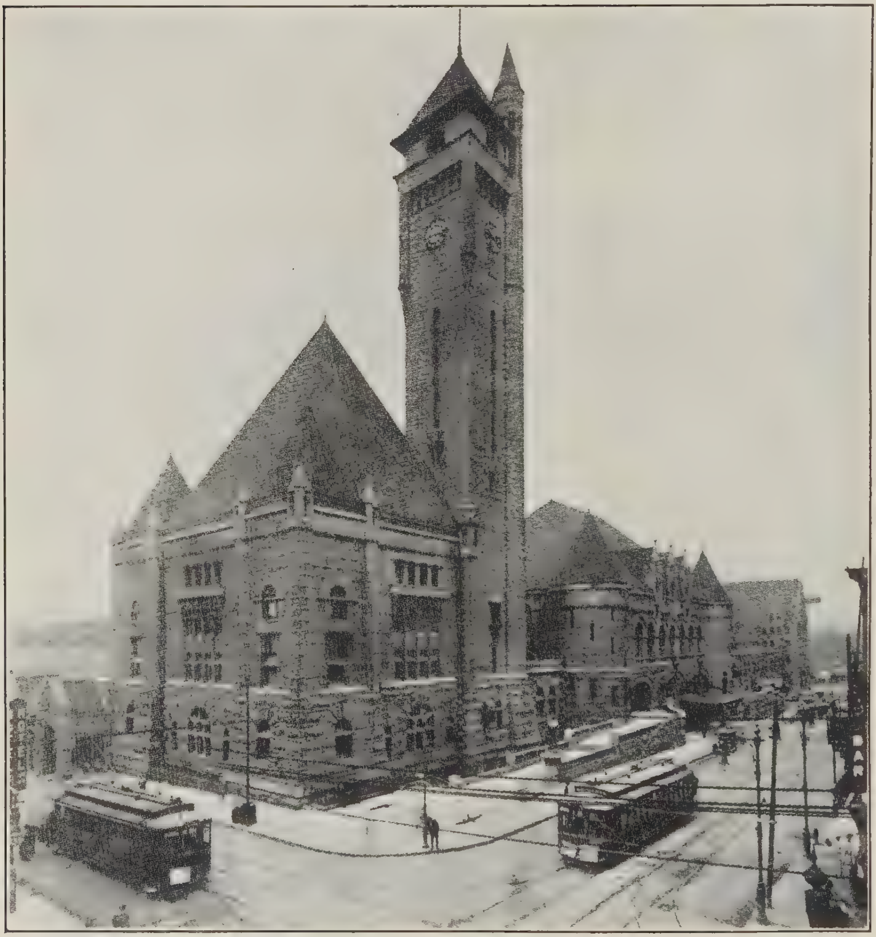

FIG. 87.—Union Station, St. Louis, Mo.

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[1] During the World's Fair period. In the year ended June 30, 1914, 1,699,433 pieces of baggage were handled.

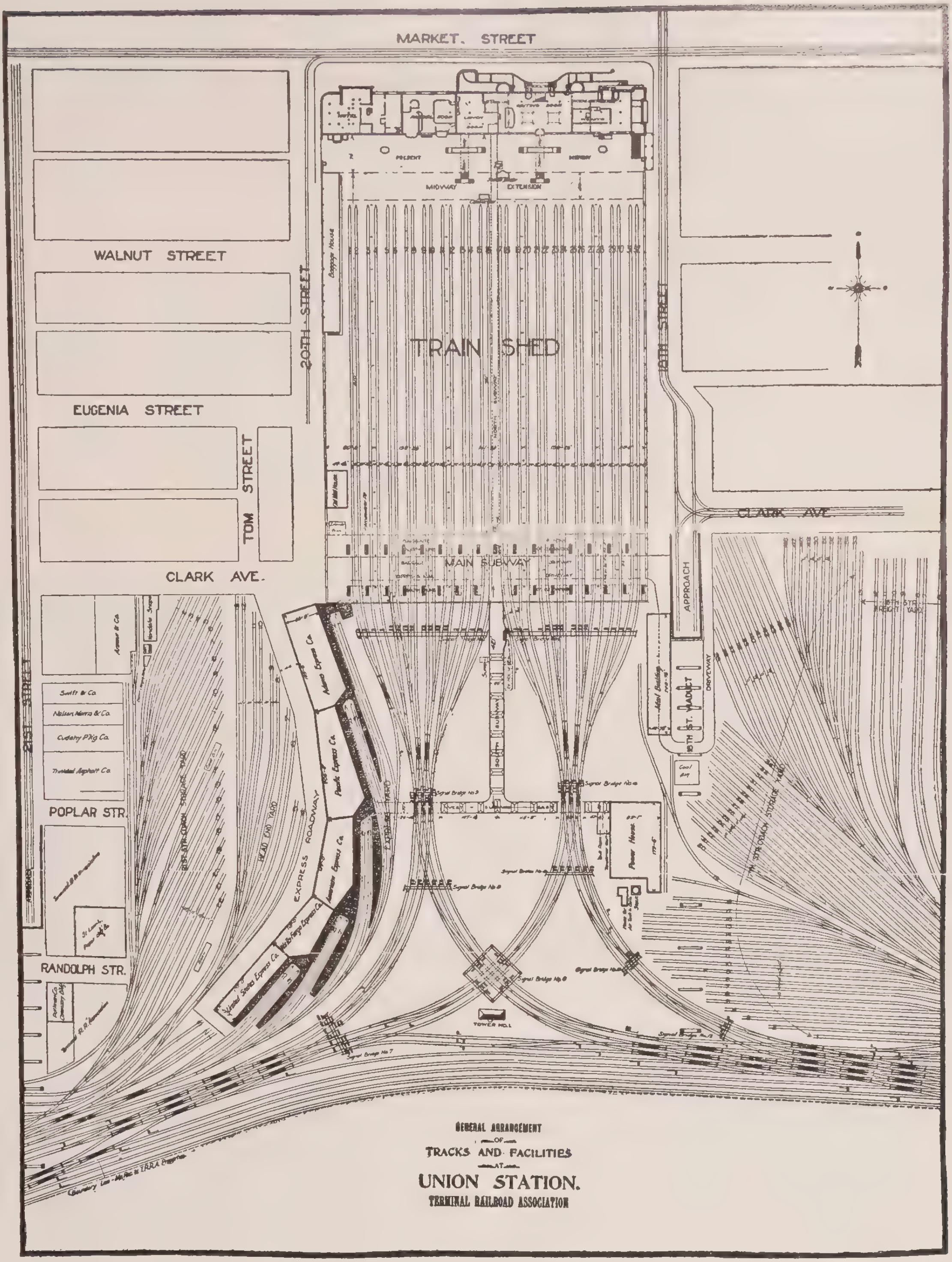


FIG. 86.

(Facing page 124.)

In the year ended June 30, 1914, the passenger trains in and out of the station numbered 104,980; the number of cars was 575,201. The station is owned by the Terminal Railroad Association of St. Louis. It is used by 27 railroads and practically the entire passenger traffic of St. Louis arrives at or departs from it.

The view in Fig. 90 and the plan in Fig. 89 are of the new Central Station at Ottawa, Ontario, opened on June 1, 1912, and occupied by the Grand Trunk, Canadian Pacific and the New York & Ottawa. It is, in reality, a hotel and station combined. The main waiting room shown on the plan of the station is 52 ft. square with wide wings each 50 ft. square and 40 ft. high. Alcoves and rooms for the ticket office, information bureau, parcel room, lunch room, etc., open from it and over the central portion there is a large dome at the bottom of a light well which furnishes light to the interior offices in the building above. A broad stairway at the north end of the waiting room leads up to the Laurier Plaza, which is 22 ft. above the track level. The women's waiting room, which is adjacent, is 52 ft. by 30 ft., and is well lighted from the open areas on each side of the entrance. The smoking room is 32 ft. square,

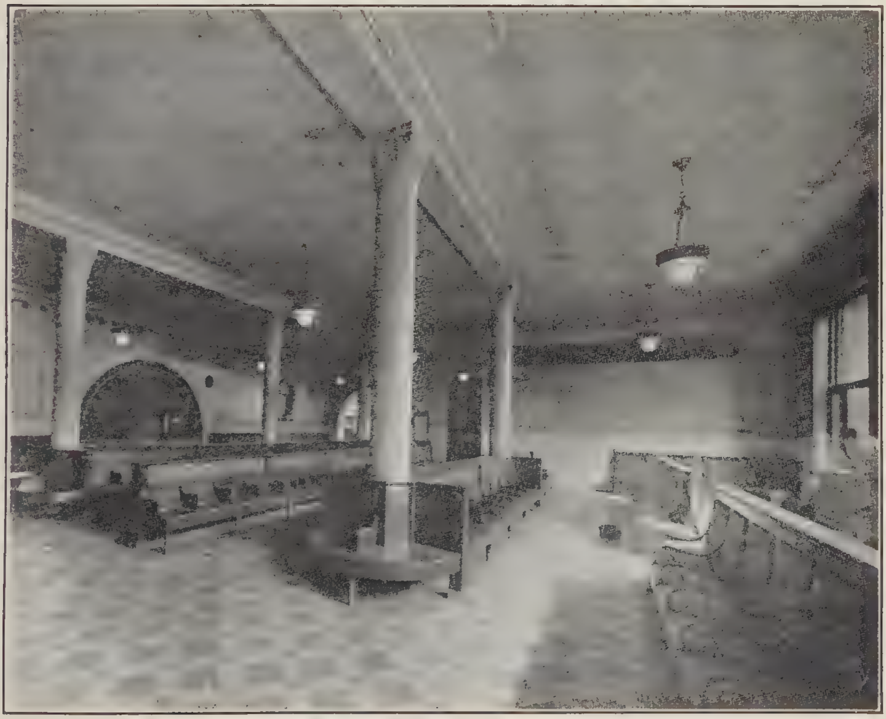


Fig. 88.—Waiting room of St. Louis Station.

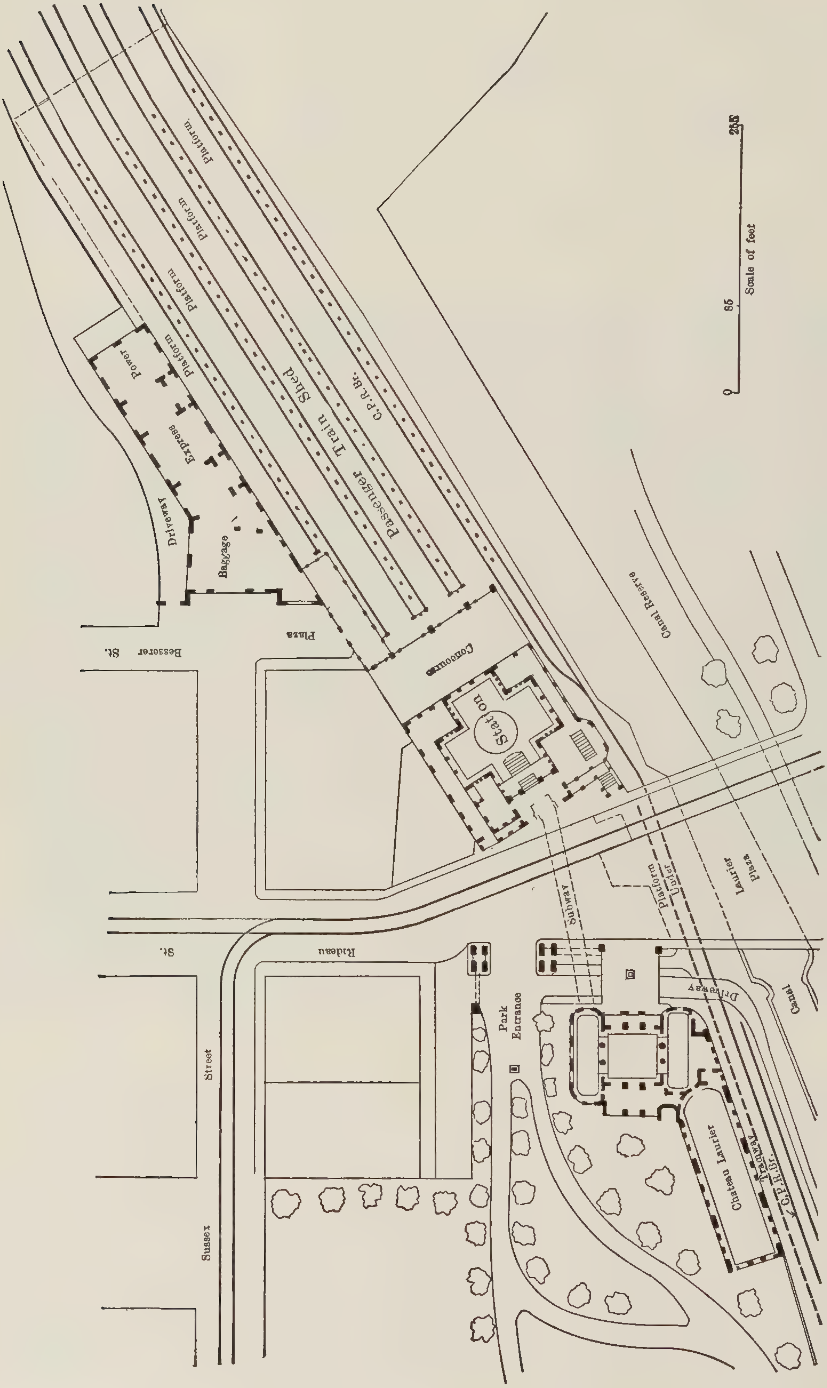


FIG. 89.—Layout of Central Station, Ottawa.

the ticket office 52 ft. square, the lunch room 52 by 35 ft. and sleeping car office, telegraph office and information bureau each 15 by 20 ft. On a mezzanine floor there are rooms for the offices of the train despatcher, the station master, etc. The station facilities also include a suite of private waiting rooms for the use of government officers and distinguished visitors. The train shed covers nine tracks, served by platforms 20 ft. wide. The concourse, 170 ft. by 50 ft., which lies between it and the station buildings, is at track level. It communicates on the north with the general waiting room, which is at the same level, and on the east with the street. Baggage is handled in the baggage and express annex, about 350 ft. long, just east of the train shed. This one building is provided with separate tracks and platforms and takes care of both inbound and outbound baggage, express, and mail. There are driveways leading directly to it. The Chateau Laurier covers an area of 25,000 sq. ft. Its main entrance is from the Laurier Plaza, but there is a service entrance underneath from the level of the roadway which leads to the canal and also a large passenger subway connecting the hotel with the station. The building has over 300 outside rooms and connecting baths aside from the ball room, and the public and private banquet and dining rooms.

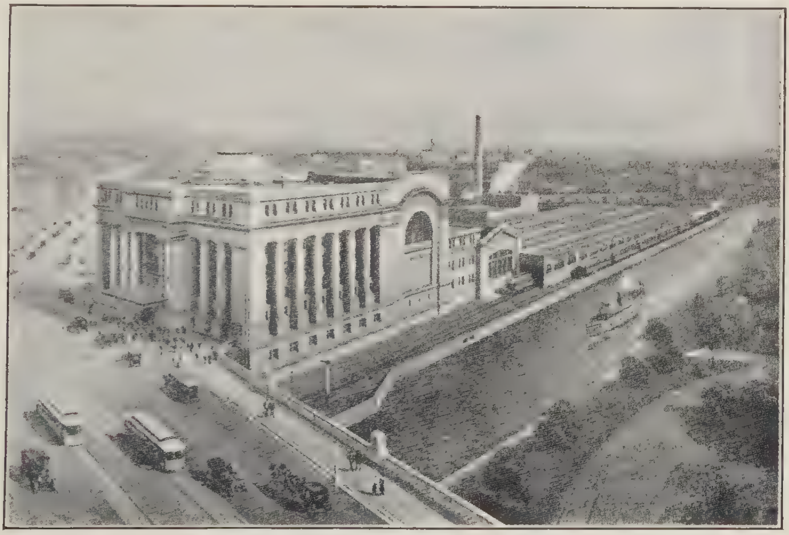
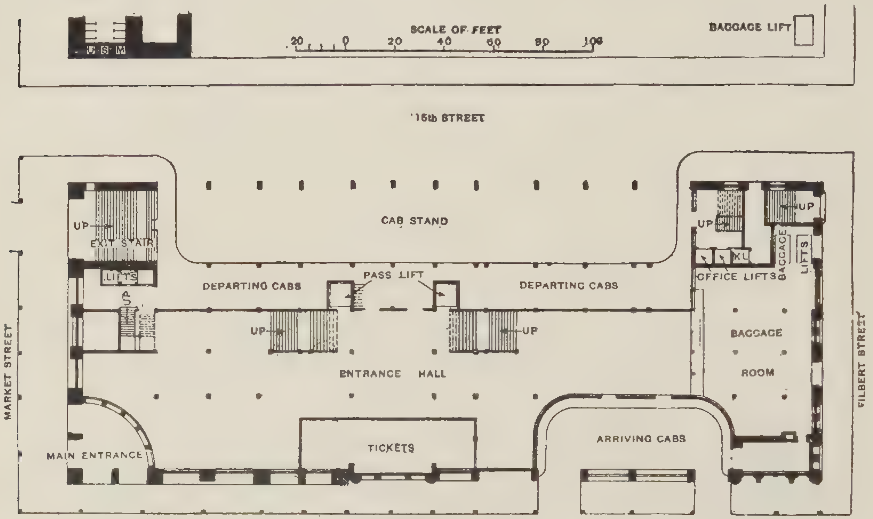
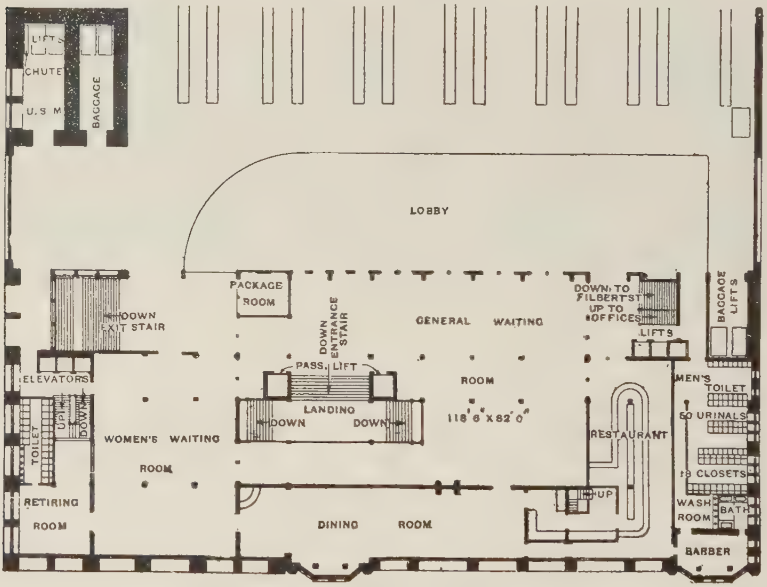


Fig. 90.—Central Station, Ottawa.

A plan of the Pennsylvania Railroad's Broad Street Terminal in Philadelphia is shown in Fig. 91. This station was built in 1882 and reconstructed and enlarged in 1893. Although not by any means the busiest terminal in the country it has always ranked among the most important. The station is placed in an exceptionally convenient position at the corner of Broad and Market Streets so that the Pennsylvania, like the Philadelphia & Reading which has its terminal a few blocks distant on Market Street, is able to bring its patrons squarely into the



Plan of Ground Floor



Plan of Second Floor (Track Level).

FIG. 91.—Layout of Broad Street Station, Philadelphia.

business and financial center of the city. The Broad Street Terminal handles both through and local traffic but it does not handle all of the Pennsylvania Railroad's passenger traffic at Philadelphia for there are other stations handling both through and local business at West Philadelphia, North Philadelphia and Camden, N. J.

The tracks at this station are on a level above the streets. The station itself fronts on Broad Street and its approach tracks are on an elevated structure running west parallel to Market Street. The plan will show the general layout of the station. The Broad Street front is about 305 ft. wide. On its left-hand side there is a tower at the foot of which is the main entrance. The entrance hall is about 70 ft. wide. The ticket office on its Broad Street side is 20 ft. wide and 75 ft. long and is in a very convenient location. The baggage room measures 45 ft. by 68 ft. and is likewise convenient being near the ticket office and the spaces for both arriving and departing cabs. Baggage has to be taken upstairs on the baggage elevators. There are also two elevators for passengers, one on each side of the main stairway, each elevator being able to carry about 50 persons. The general waiting room on the second floor measures 82 ft. by 120 ft. and gives access to the lunch and dining rooms, the women's waiting and retiring rooms, the parcel room and the train shed. The men's toilet and a barber shop are on the Filbert Street side readily accessible from the lobby. The train shed covers 16 tracks.

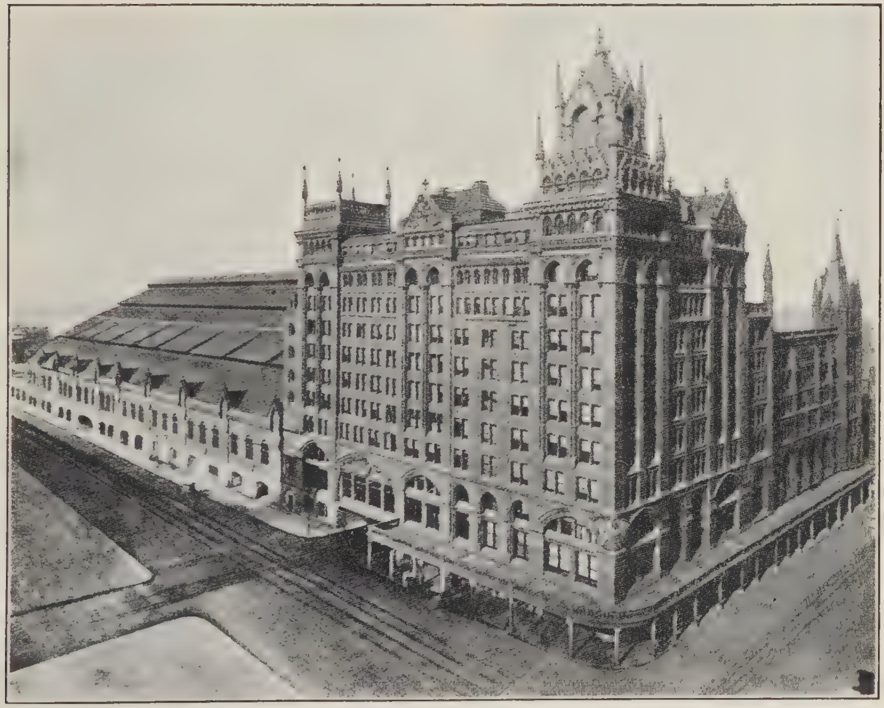


Fig. 92.—Broad Street Station.

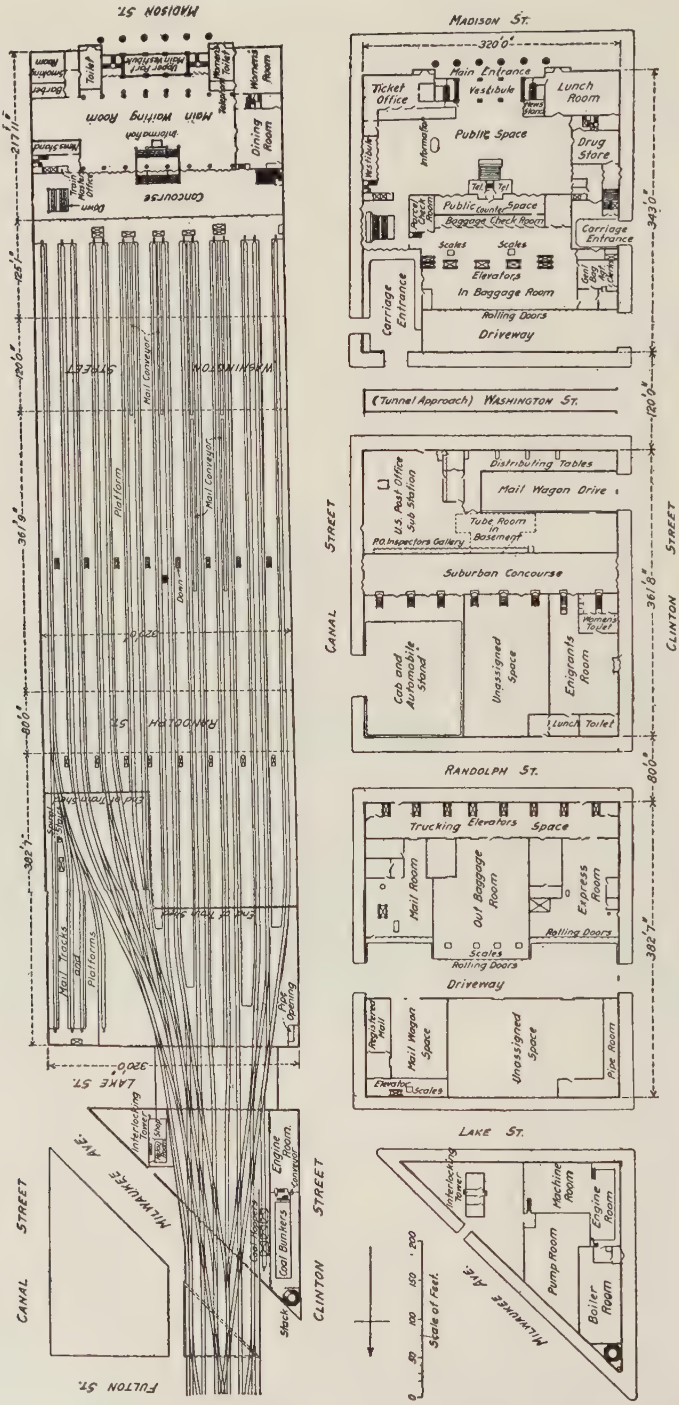


FIG. 93.—Plan of street and track levels, Chicago & North Western Terminal.

It is 600 ft. long and its arch spans the entire width of 305 ft., being 150 ft. high at its highest point. The total length of both head house and train shed is about 410 ft.

A thing that should be noted about the station is the passageway for 15th Street just behind the headhouse and the space for cabs connected therewith. The ready means of exit from the station are likewise noteworthy and commendable.

The Pennsylvania Railroad has recently completed the work of electrifying its four-track line from the Broad Street Terminal to Paoli, 20 miles. It has been thought that it would eventually be necessary to use the facilities at the station for local service alone and to serve the through patrons at West Philadelphia and North Philadelphia. This electrification, however, is intended as another solution of the problem. It is hoped that electrical operation will result in an increased train capacity at Broad Street and if the idea works out successfully it will also be applied to other of the Philadelphia suburban lines as, for instance, the line to Chestnut Hill.

The new passenger station of the Chicago & North Western in Chicago is a splendid example of much that is best in passenger terminal design not only as regards beauty and convenience but also as regards the number and completeness of its facilities. The terminal occupies a position between Canal and Clinton Streets and extends back from the main entrance on Madison Street to the corner of Milwaukee Avenue and Clinton Street, a distance of 1,670 ft., Washington, Randolph and Lake Streets being carried under the structure through subways.

The station proper is 320 ft. wide and 218 ft. long. The view in Fig. 94 shows the magnificient colonnaded main entrance on Madison Street, 140 ft. high crowned by a clock 12 ft. in diameter. The walls and columns are of gray Maine granite. Three large arches in this main entrance give access to the corner vestibule and thence to the public court, 100 ft. by 250 ft., which is also accessible from another entrance on Canal Street. In this court on the Canal Street side is the ticket office containing 33 selling windows. Other facilities, including a lunch room, drug store, information bureau, telephone booths, telegraph offices, parcel check room, automobile and cab booths and the baggage room are also grouped about this court, the baggage checking counter being placed in a convenient position under the grand stairway to the upper level. The baggage room is directly behind the stairway. It opens upon a driveway, leading from Clinton Street parallel to Washington Street and connecting by means of a gate with a carriage entrance on the Canal Street side, stairs leading from the carriage entrance to the concourse, and an entrance leading also to the baggage room.

A broad stairway leads from the public court to the general waiting room on the track level. This room, 202 ft. long and 117 ft. wide, is treated as a Roman atrium with a barrel vault roof. The pilasters and the entire order up to the spring of the vaulted ceiling are of dull-finished light pink Tennessee marble, the columns being of Greek Appollino marble, of a delicate green hue. The lighting of the room includes clusters of incandescent lights on solid bronze fixtures with a complete system of indirect lighting concealed behind the cornices. The seats in the room are of mahogany.

A separate waiting room for ladies[1] is provided at the west end of the waiting room floor. Adjoining this is the main dining room[2] 79 by 59 ft., served from a kitchen on the floor below. At the east end of the main waiting room are the barber shop, news stand, a smoking room and free and pay toilets. Above, on the third floor, are provided ladies' rest rooms, dressing rooms, wash rooms and baths, a ladies' tea room, and the nurse's and matron's rooms. Adjoining the latter room is a physician's office and emergency department. The facilities for hospital and emergency service are very complete and are furnished free of charge. On the same floor are the men's lounging room, men's barber shop and bath rooms. These facilities are much like those found at the club and are designed for the visitor who may have to wait over for his train or more especially for the commuter who can change to evening dress and keep an evening appointment without having to go home.

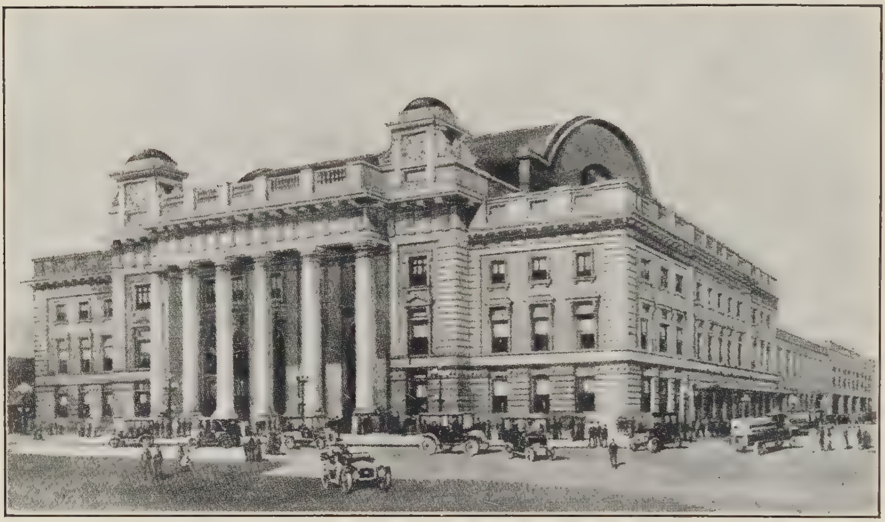


Fig. 94.—North Western Terminal.

The station concourse directly behind the waiting room is 60 ft. wide and 320 ft. long. It is completely enclosed and is heated in winter to

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[1] See Fig. 15.

[2] Fig. 219.

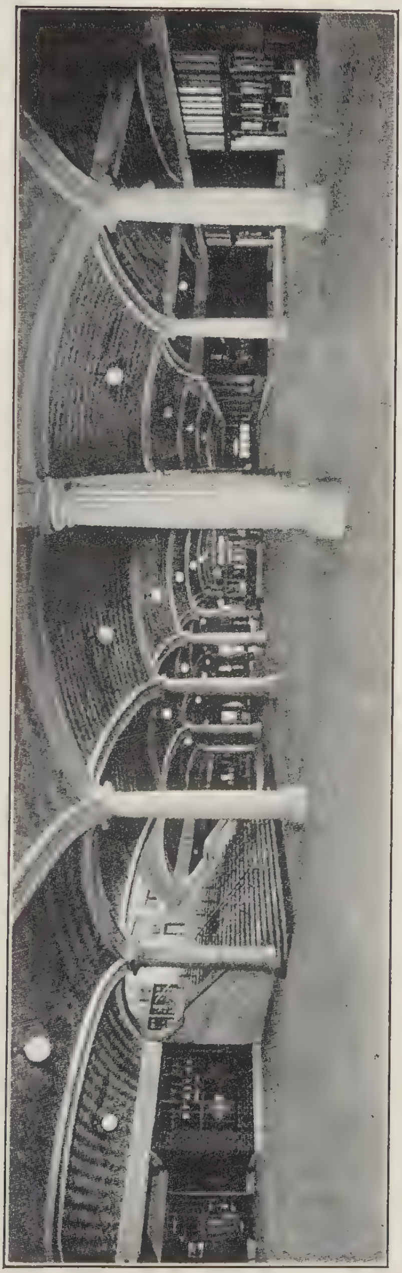

Fig. 95.—Public court, North Western Station.

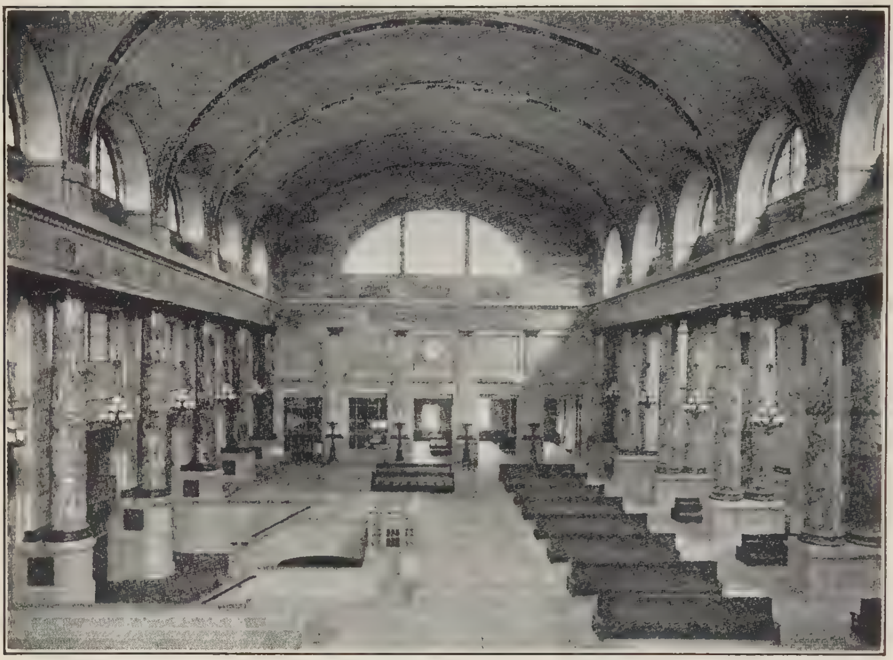

Fig. 96.—Waiting room, North Western Terminal.

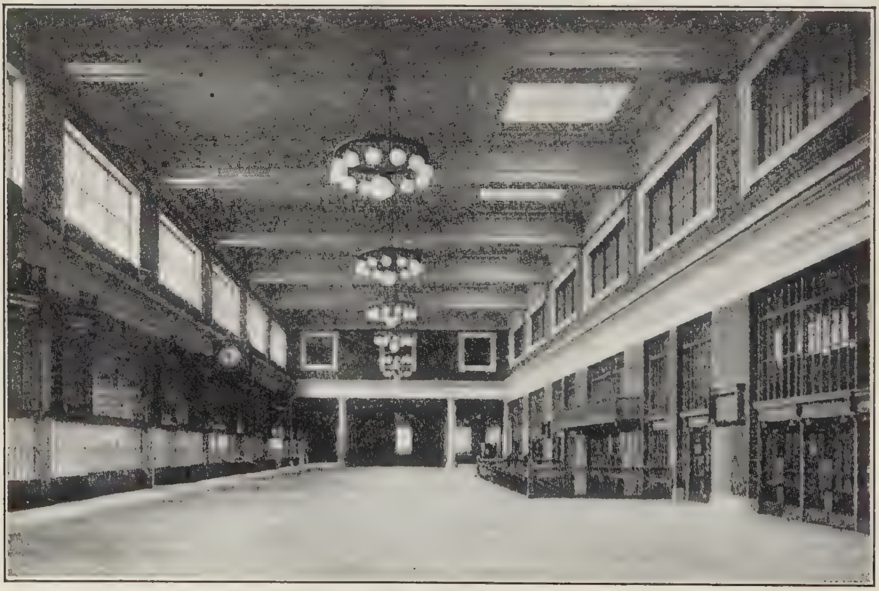

Fig. 97.—Concourse, North Western Station.

a comfortable temperature. The train shed[1] which is of the Bush type, covers 16 tracks, each with a capacity of 15 cars, and has a total length of 894 ft. The floor construction is of concrete throughout so that the space between the tracks may be flushed and easily kept clean.

The elevator shafts from the incoming baggage room on the ground floor open immediately behind the track bumpers. The three tracks on the Clinton Street side and the five on the Canal Street side were intended for through trains. Between these tracks there are belt conveyors flush with the floor for carrying mail to the distributing tables in the post office substation on the floor below. Incoming baggage is loaded on trucks and carried down on the elevators to the incoming baggage room. Outgoing baggage, mail and express are brought up in the same way from the outgoing baggage room and the mail and express rooms adjoining.

The street car tunnel under the river on Washington Street comes to the surface within the walls of the terminal. On the north side of Washington Street is located the post office substation mentioned above. Immediately north of the post office there is a smaller concourse set apart for the use of suburban patrons, there being eight stairways upstairs to the train platforms. By the use of this concourse suburban patrons can get to their trains without having to go through the main waiting room. On the corner of Canal and Randolph Streets there is a cab stand for use in connection with the concourse.

The immigrants' room is on the corner of Randolph and Clinton Streets. It is well furnished, its facilities including a lunch room, complete toilets and baths for men and women and wash rooms, including steam dryers, whereby the immigrant women may do washing for their families and have it dried while they wait.

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[1] Shown in Figs. 21 and 25

CHAPTER VI

WATER FRONT TERMINALS

The problem of transferring passengers with the usual accompanying "impedimenta" of hand and truck baggage, and mail and express matter from trains to water craft and *vice versa* presents some peculiar features which differentiate it from ordinary terminal work. The character of the water service ordinarily determines the general plan of construction and the methods of operation to be followed.

The water service may be that of ocean or coastwise liners, in which case connecting trains are run onto the pier alongside the steamer and considerable time is taken to transfer the passengers, baggage and mail "broadside" into or out of the ship. Typical instances of this type of terminal are the water front connections made between the Canadian transcontinental lines and their connecting trans-Pacific or trans-Atlantic steamers at Prince Rupert, Vancouver,[1] Montreal and Portland, Me., those made between the Boston & Albany and certain of the trans-Atlantic lines at East Boston, Mass. and those between the coastwise steamship lines of the New England Steamship Company and the New York, New Haven & Hartford at New Bedford and Fall River, Mass., Providence, R. I. and New London and New Haven, Conn. A more recent terminal is that giving connection between the Florida East Coast and the Havana, Cuba steamers which was for several years maintained temporarily at Knight's Key, Fla., but more recently transferred to a permanent position at Key West.

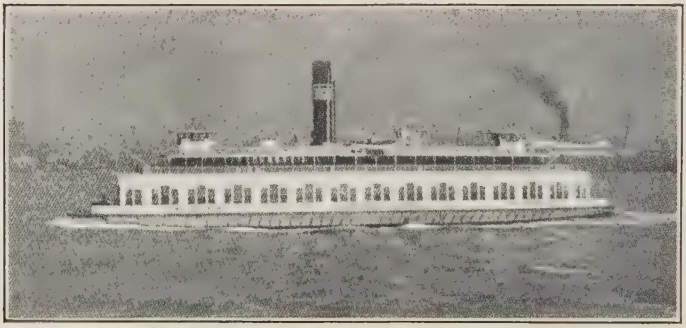

FIG. 98.—The Lackawanna ferry-boat "Elmira."

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[1] See Fig. 107.

Another method of rail and water interchange is that by means of which solid trains of cars are carried on car floats or steamer transfers from the rails on one side to those on the opposite side of an intervening stretch of water. This was at one time done across New York harbor in the movement of the New York, New Haven & Hartford and Pennsylvania Federal and Colonial Express trains running nights and days respectively between Washington and Boston. These trains which were quite heavy, running from eight to twelve cars, were taken down the East River and around the Battery, a distance of some 14 miles, by the big transfer steamers Maryland and Express.

The transfer of this character by the New York, Philadelphia & Norfolk between Cape Charles, Va. and Norfolk Va., is interesting because of its length—36 miles across the mouth of Hampton Roads—and its intensive development since 1883 by the Pennsylvania under the leadership and direction of former President Cassatt.

A great volume of passenger traffic is handled by ferry boats. The amount so handled in New York harbor, in particular, is probably much in excess of that at any other place. Of the total business done at that point that done by the ferry lines operated by railroads including the Delaware, Lackawanna & Western, the Erie, the West Shore, the Pennsylvania and the Central of New Jersey probably constitutes the larger share. The construction of the various tunnels or tubes under the East and North Rivers has tended to reduce the volume of this ferry travel somewhat but it still remains of exceedingly great importance, notwithstanding.

The ferry traffic at San Francisco is also very extensive. In 1913 over 40,000,000 passengers were carried between San Francisco itself and Oakland, Alameda, Richmond and Sausalito, the bulk of this being handled by the Southern Pacific. San Francisco is at the head of a peninsula and is separated from the mainland proper by San Francisco Bay, on the eastern shore of which are several thickly populated communities including Oakland, Berkeley, Richmond, Alameda, Piedmont and Albany. There is one extensive ferry terminus in San Francisco at the foot of Market Street from which ferry lines are operated by the Southern Pacific, the Western Pacific and the San Francisco-Oakland Terminal Railways (the Key Route) east across the bay to Oakland and Alameda; by the Northwestern Pacific northwest to Sausilito and by the Santa Fe north to Richmond. The Southern Pacific connects at Alameda with the line south to Los Angeles through Bakersfield and central California. At Oakland, the more important pier, it makes connection with the trans-continental line to Ogden running north some distance along the shore of San Francisco Bay, but the larger part of the service out of the ferry pier at Oakland is suburban handled by multiple unit trains. The Key System also uses such equipment. The ferry stations on the Oakland and Alameda sides of the bay are some distance out from land owing to the shallow water. The piers connecting them with the mainland are noteworthy in as much as they are a mile or two in length.

The view in Fig. 98 of the Elmira operated by the Lackawanna Railroad is fairly typical of the ferry boats now in service between the railroad ferry stations on Manhattan and the various railroad terminals in Jersey City, Hoboken and Weehawken, New Jersey on the opposite side of the North River. It should be noted that the boat has two decks and that passengers may board or leave the boat from the upper as well as the lower deck. The Elmira like most of the ferries now in service on the North River and those operated by the city on its Staten Island service has screw propellers and, of course, can move with equal facility in either direction.

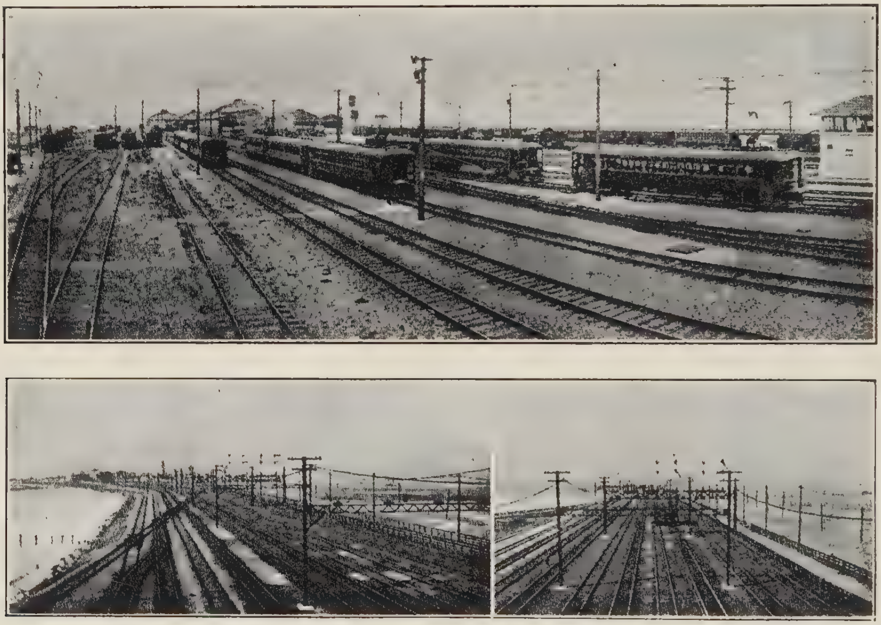


Fig. 99.—The Southern Pacific Terminal at Oakland and two views of Oakland Pier.

The boats used at San Francisco are essentially similar to the New York boats. As they have much longer trips, however, the time required on some of the routes being from one-half to three-quarters of an hour, they are usually provided with lavatories, news stands, lunch and dining rooms and similar facilities which are not needed in the New York service.

As these boats must move with utmost rapidity it is highly necessary that they be able to dock in the shortest possible time. The view of the layout of the Central Railroad of New Jersey's new Jersey City

Terminal in Fig. 104 will give a general idea of the location of the ferry bridges and the long slips which lead up to them and a more detailed plan may be found in the illustration in Figs. 101 and 102 in which are shown the slips of the 23rd Street Station described below. A plan of the Jersey City slips is given in Fig. 100. The bridge is capable of being raised or lowered to suit the height of the boat or tide. It is also so arranged that when the boat has come into the slip it is immediately made fast by two hawsers, one on each side of the bow, which are pulled in by electric or hand-operated windlasses. To prevent damage to boats or docks it is also necessary that there be a buffer arrangement to take up the shock of docking.

The ferry piers at the Jersey City station are of modern pattern. The bridges at the ends of the piers are suspended from the ferry-house structure and are raised and lowered by 20-h.p. alternating-current motors at a speed of about 7 ft. per minute. The buffer used to absorb the shock of the boats is of special design. The pivoted end of the bridge has its bearing near the outer end of a spring platform, 19 ft. long, which transmits the shock through heavy coil springs to a buffer platform 23 ft. long which is separated from the heavy concrete bulkhead in turn by similar springs. The spring platform consists of timber piles supporting a timber deck, and the buffer platform of timber piles supporting a timber framework, which is entirely independent of the deck carrying the floor over the platform.

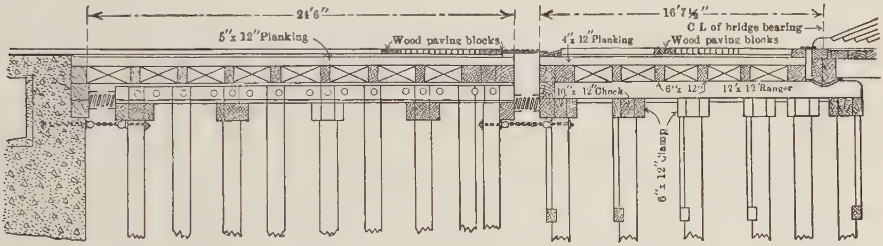
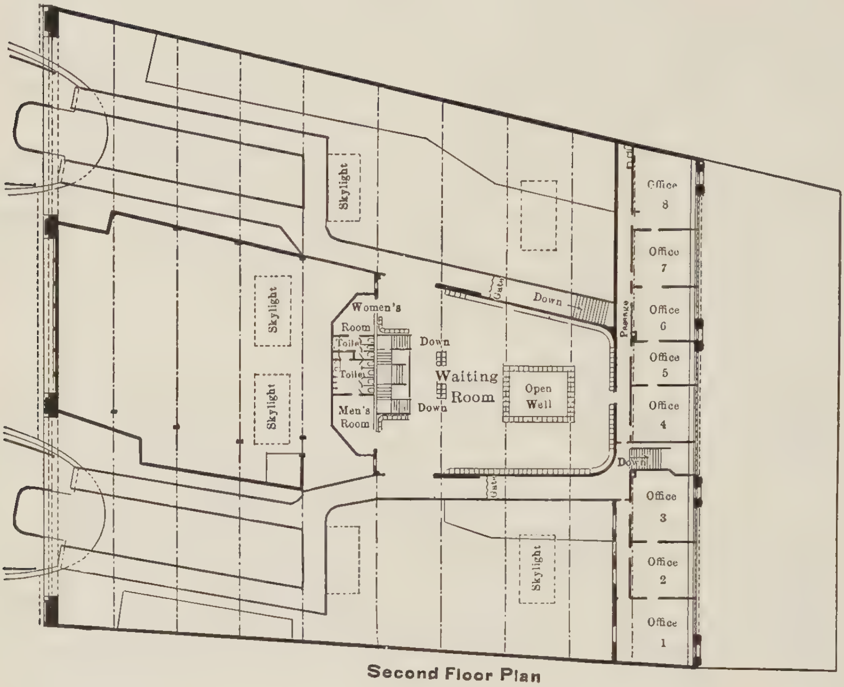


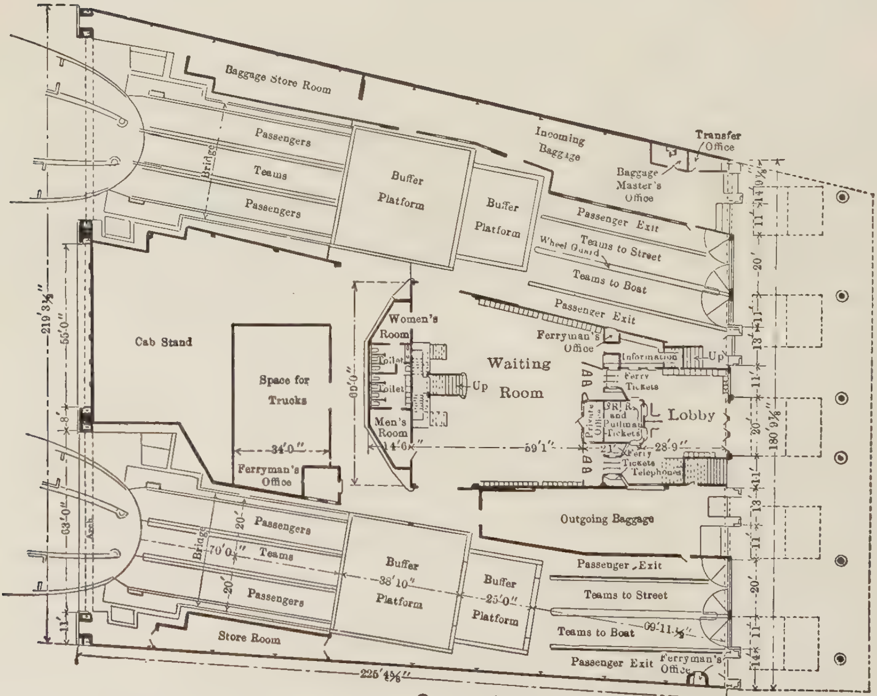
Fig. 100.—Details of buffer platform of ferry slip.

An up-to-date and fairly typical ferry-house layout is that of the Central Railroad of New Jersey, the Delaware, Lackawanna & Western and the Erie on the North River at West 23rd Street, New York, of which part of the West Street elevation is shown in Fig. 103, the ground and second floor plans of the Central of New Jersey house in Fig. 102 and those of the Erie house in Fig. 101.

The three buildings are on the whole an excellent example of ferry-house architecture. It is true, however, that any one of the three may be taken as typical of the majority of the ferry houses in New York City devoted to railway service. The three houses are of steel frame construction sheathed on the outside with ornamental sheet copper. The

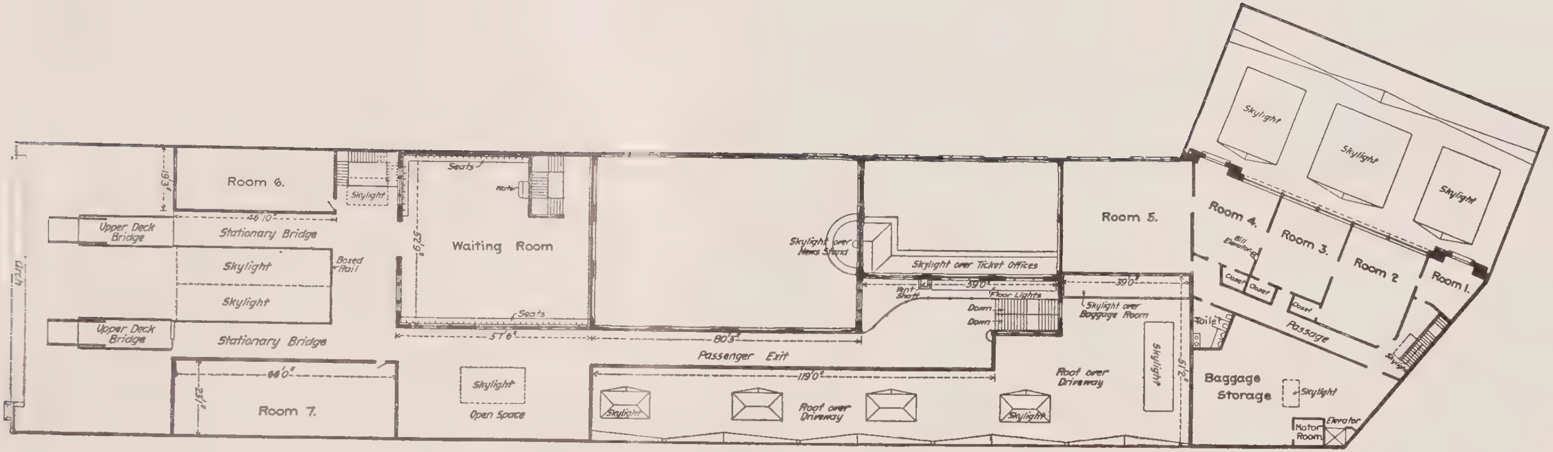


Second Floor Plan

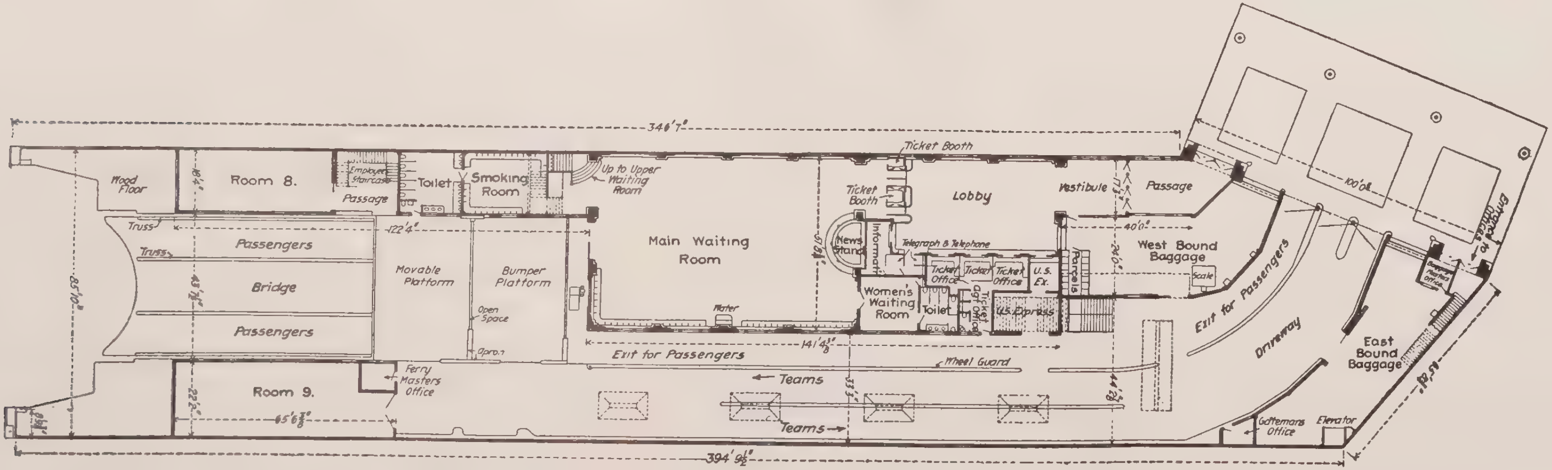


Ground Plan

Fig. 101.—Erie Station at West 23rd Street, New York.



Second Floor Plan.



Ground Plan.

Fig. 102.—Plan of Central of New Jersey ferry station, West 23rd Street, New York.

(Facing page 140.)

interior finish is likewise of sheet metal painted and improved by trimming of light wood. The houses have no projecting hoods as in many older and smaller layouts, but the boats run directly into the buildings for some distance with the result that in stormy weather much better protection is afforded to patrons. Following the usual scheme also the bridges are so made that passengers can be unloaded directly from the upper decks of the boats. The ground floor of each house is provided with a large general waiting room, toilet rooms, baggage rooms, ticket offices and information bureau and other incidental facilities. The second floors likewise contain large waiting rooms and also offices. The layout in each case is so arranged that incoming passengers use separate exits and cannot go through the waiting rooms.

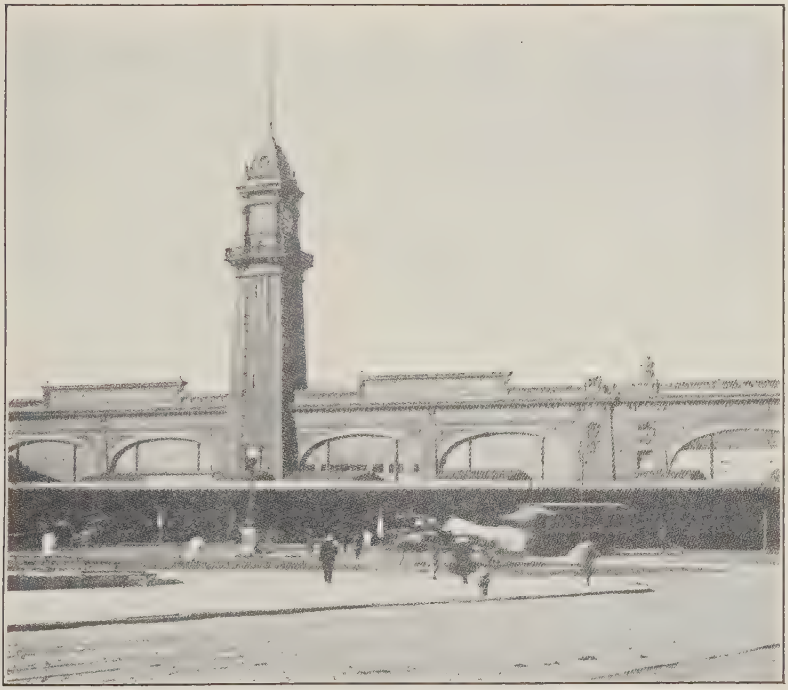


FIG. 103.—Lackawanna ferry station, West 23rd Street, New York.

In the Central of New Jersey building the floors of the main waiting room and the passenger exits are of asphalt. The driveway for teams, on the other hand, is paved with creosoted wood blocks. The waiting room of the Erie station has a floor of $\frac{7}{8}$-in. maple; the passenger exit has a floor of $\frac{7}{8}$-in. yellow pine, and the team driveways are of 3-in. spruce.

The slips are six in number. Of these the Central Railroad of New Jersey uses one and the Erie two. The Lackawanna uses the remaining three, two for boats running to its Hoboken terminal and one for the ferry which it operates to 14th Street, Hoboken.

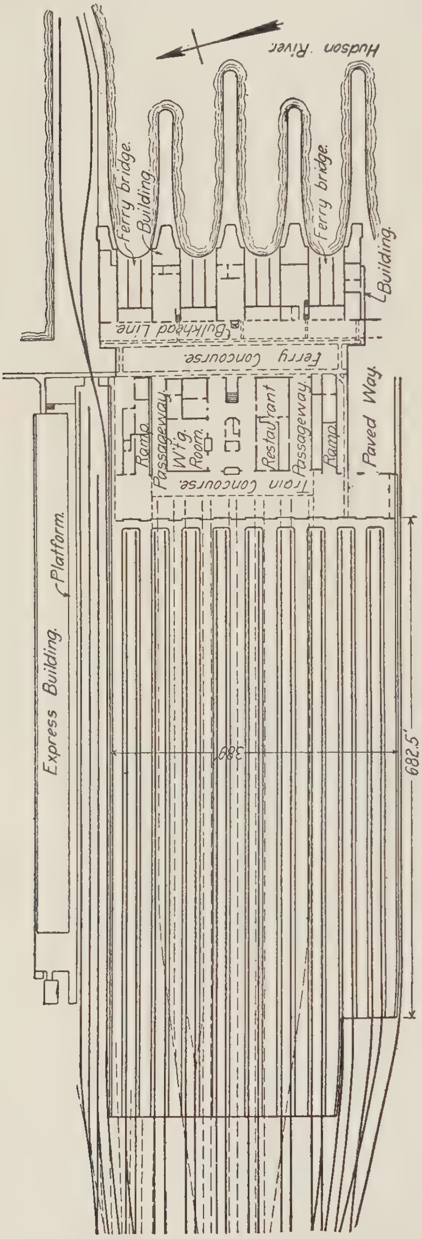


FIG. 104.—Layout of Jersey City Station, Central of New Jersey.

The one disadvantage that the terminal suffers is its relative inaccessibility. It is several blocks from both subway and elevated lines so that all persons who use the cars have to come on the cross town surface lines. These cars loop in front of the station and deposit their passengers a short distance from a long shed or marquise of iron and glass, 50 ft. wide and 600 ft. long, which extends along the front of the buildings. The cost of the three ferry houses was about $800,000.

The water front terminals across the river in New Jersey are similar in general design to these stations at 23rd Street and the other stations in Manhattan like them, there being the essential difference, of course, that in one case connection is made with trains whereas in the other traffic goes directly to the street. The remodelled Jersey City passenger station of the Central of New Jersey is typical. The terminal, located on the New Jersey side of the North River, not far from Ellis Island and almost opposite from the southern end of Manhattan, is used by trains of the Central of New Jersey, the Philadelphia & Reading, the Baltimore & Ohio and the Lehigh Valley. It does a considerable commutation business but also has several important through trains as well. There are two lines of ferry boats operated from its slips, one line to the 23rd Street station, described above and the other to the station at the foot of Liberty Street.

As can be seen from the plan of the recently remodelled station in Fig. 104, the head house has two levels. As the boats, themselves, have upper decks, passengers may board or leave them either directly on the lower level or by either of two long bridges or gangways extending out to the upper deck. Persons leaving boats from the lower level cross the lower ferry concourse, a space 75 ft. wide and 348 ft. long, and may then proceed by one of three passageways through the headhouse proper to the train concourse. The middle one of the three passes by the ticket offices through the old waiting room which was formerly the main thoroughfare from boats to trains. The upper ferry concourse is 50 ft. wide and 302 ft. long. It, likewise, is connected with the concourse by three passageways, two being on ramps on a 9.5 per cent. grade and the third a stairway leading directly to the old main waiting room. The lower level concourse is used by horses and teams which enter or leave by either the north or south end. The upper concourse, of course, is not. It has, therefore, been made very much cleaner and lighter and is provided with a barber shop, a drug store and a number of similar facilities.

The new waiting room is to the right of the former waiting room and is no longer used as a main thoroughfare. The restaurant is directly opposite in a very convenient position.

The train concourse, 63 ft. wide and 383 ft. long, is 350 per cent. larger than before the remodelling took place and is now ample in size for the work it has to do. The station has 20 tracks. The train shed, having a maximum length of 818 ft. and a width of 370 ft. covers 18 of the station's tracks and is one of the best Bush sheds installed up to this time. The platforms range from 16 ft. to 20 ft. in width, the wider ones, of course, being in the center where most of the trucking must be done to the through trains which use these tracks. The train platforms are separated from the concourse by sliding gates equipped with Hutchinson indicators and a system of light signals for starting trains. This system which was worked out by the company's engineering department differs somewhat from that used elsewhere in that the tower operator receives the signals from the ferrymaster, gateman and conductors, but does not answer except by lining up the route and displaying the clear signal at the end of the shed.

This layout, as can be seen from the illustrations of it in Figs. 16 and 17, is nothing extravagant or exceedingly beautiful. It is, however, a very convenient station.

The Delaware, Lackawanna & Western station at Hoboken is very similar to the Jersey Central station, but is built on a somewhat more elaborate plan. This layout like the other has two levels. It has, however, six slips instead of four, for the Lackawanna operates boats to 23rd Street, Christopher Street and Barclay Street. It also has the advantage of being on the line of the Hudson & Manhattan, and is, therefore, much more accessible. The traffic at the station is predominatingly suburban, although there are also a number of important through trains to Buffalo, making connection for Chicago and other points west.

The station was opened on February 25, 1907. It was built over traffic and replaced an old structure destroyed by the great Hoboken fire of August 7, 1905, at a rather opportune time when plans for the new station were almost completed and steps taken leading to the demolition of the old one.

The station is so much like the remodelled Jersey Central station that it is not worth while to describe it in full detail. It is worth noting, however, that the Lackawanna station is the more ornate and solidly built structure of the two. It is an absolutely fireproof structure on a concrete foundation supported on piles. Its exterior is covered with metal sheathing made to appear like laths and certain parts of the interior are covered with copper treated with acid so as to produce different shades of green and brown. The tower shown in the illustration in Fig. 105 is the striking feature of the station as one approaches from the water side. It is 200 ft. in height and the face of the clock in its side has a diameter of 12 ft.

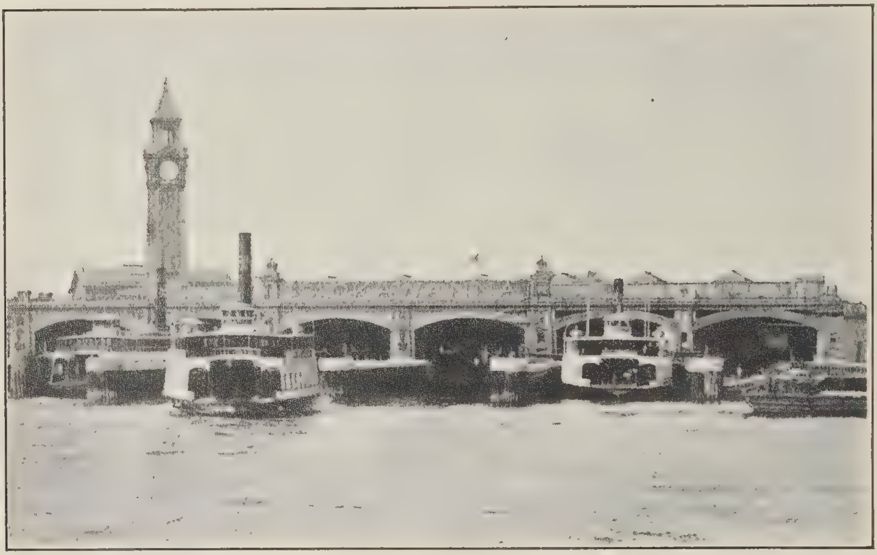


FIG. 105.—Lackawanna Station, Hoboken, N. J.

The general waiting room, 100 ft. square and 50 ft. high, is trimmed with limestone to the level of the second floor and with plaster and ornamental iron and bronze above. On the right as one enters from the lower level concourse are the men's smoking room and toilets. The ticket office is adjacent. This office has but four windows; but it will be remembered that the predominating share of the terminal's business is suburban and that there are also ticket offices in the three ferry houses on the New York side. To the left is a lunch room and also the women's room Directly opposite from the entrance is the news stand with doors on either side leading to the concourse. This facility gives access to 16 tracks covered by a Bush train shed. This shed was the first of the several Bush train sheds that have been built, and the installation was made by its inventor Lincoln Bush who was at that time chief engineer of the Lackawanna Railroad. The concourse and the train platforms are all of concrete.

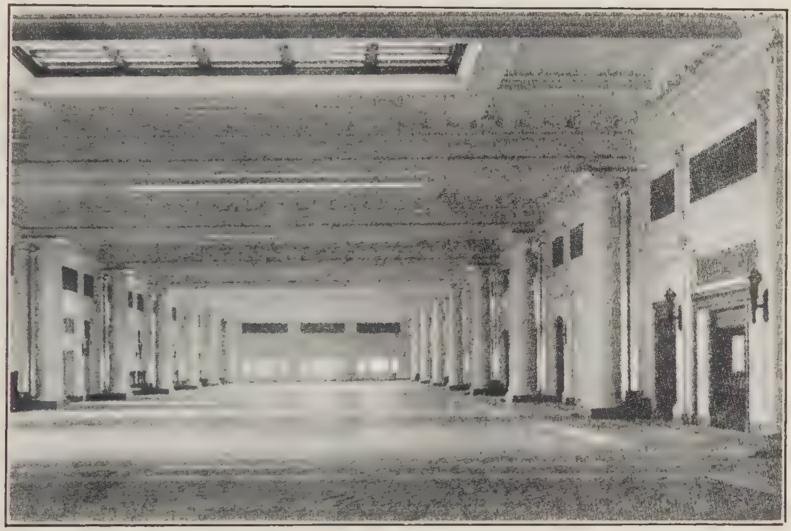


Fig. 106.—Upper ferry concourse of Lackawanna Station.

The ferry concourses of the Lackawanna's Hoboken station are set at an angle to and somewhat to one side of the station tracks. The upper level concourse is a vast hall, 70 ft. wide, extending the full width of all six slips. At its southern end there are men's toilets, a barber shop and the entrance to the dining room, the latter being on the water side of the station and provided with a balcony from which a fine view can be obtained of the North River.

The arrangement of the concourse is the one thing that subjects the station to criticism. It is an advantage, of course, in some ways that the lower level concourse should extend out directly to the street, for that means that wagons and trucks can take the shortest possible lines to the boats with the least interference with other ferry patrons. It is a disadvantage, however, that all persons going to trains should have to go through the waiting room on their way, and a decided hardship for the person coming from a boat docking in one of the further slips who may have to board a train on track 1. The same criticism applies to the upper concourse. There are three passageways from it to trains; one is a wide stairway leading directly to the train concourse, another the

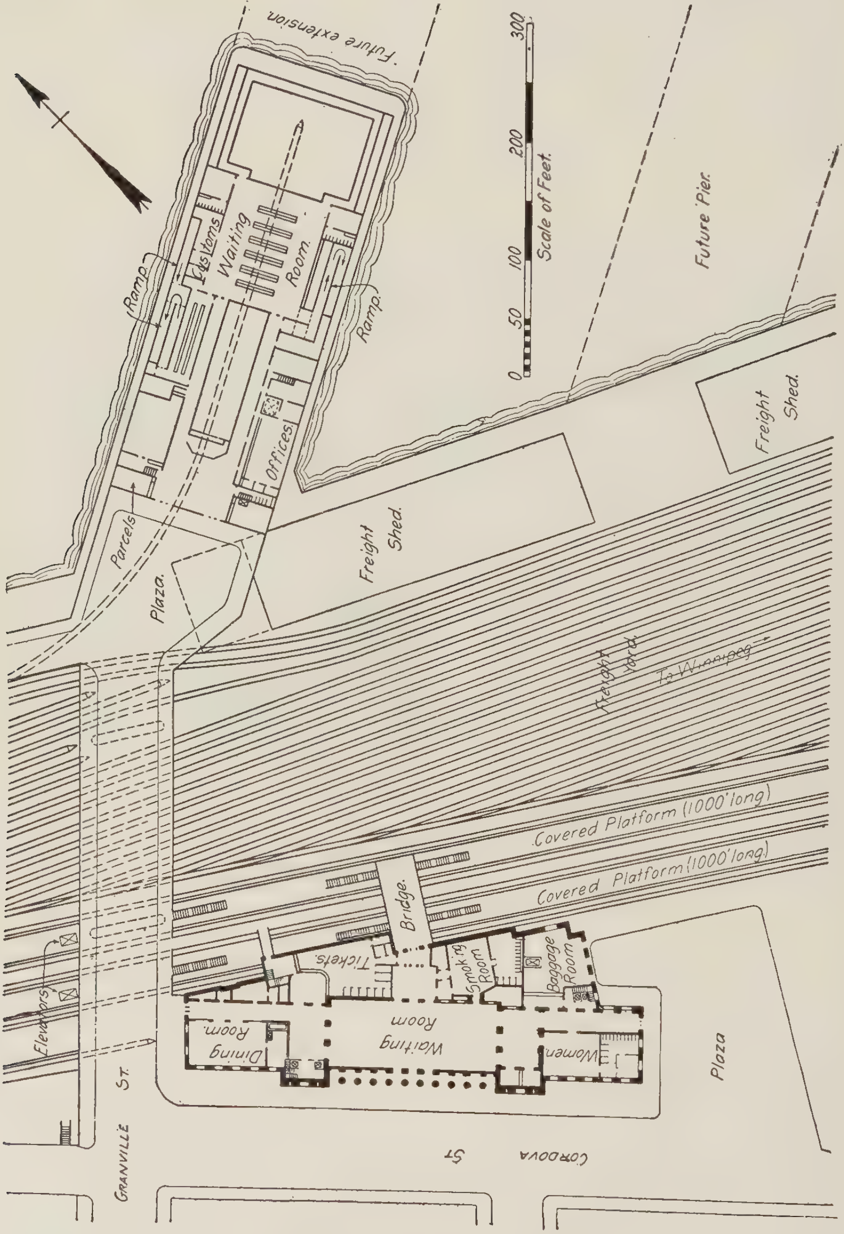


FIG. 107.—Canadian Pacific Terminal at Vancouver.

stairway down to the waiting room and the third a ramp on the extreme southern end. The only entrance, however, from trains to the upper concourse is this ramp, or to the lower concourse, an adjacent passageway below. Patrons cannot enter the ferry concourses through the waiting room or by the stairway mentioned above. An effort is made to have all trains arrive on the tracks nearest these entrances, but the idea does not work out in all cases. A person arriving on track 1, 2 or 3, wishing to board a boat for 23rd Street has to walk nearly the entire length of two concourses. The remedy would seem to be, in the case of the upper concourse, at least, to make the wide stairway an entrance to the boats and to use it for travel in both directions instead of one.

The operation of the ferries using these water front terminals involves much detail of a highly interesting character to the student of transportation problems bound as it is by the necessity of making quick movements and punctual connections with trains and by the necessity, on the other hand, of getting along with as little wharf frontage as possible, as the rentals are extremely high. The desirable scheme of operation would be to have the boats proceeding in opposite directions pass in mid-stream. It is not always possible to operate on that basis, however, nor is it possible to avoid the occasional interference and difficulty due to fog, the bane of the river service. The method of scheduling will depend upon the number of boats in service at any one time. If three boats are in use, the scheme is to have one boat remain in the slip on either side of the river until the third boat passes from one shore to the other. This plan is satisfactory if the service given is frequent enough and works especially well if there are two slips on each side so that one boat can pull out just as the other is entering the slip beside it. If the service is not adequate, however, it can be increased by the addition of more boats so that two or even four pass in mid-stream. There have been cases where because of the necessity of making repairs to a slip it has been necessary to operate boats on a seven and eight-minute headway —eight boats an hour—out of a single slip. The pilot was directed to place his boat as near the mouth of the slip as possible, head to the tide. A tug with bows high enough to catch the guard of the ferry boat then shoved the latter's bow into the slip at the moment the departing boat was clear. In this case, as in any, the retarding feature was the loading and unloading in the slip. The teams are the uncertain element, because teamsters will bring heavy loads regardless of tide conditions and it is very difficult to get these loads on and off against a "high plank"— that is a high tide going on or a low tide when unloading. It has been proposed to arrange a power winch to assist, but the idea has not been favorably received because the truckmen, endeavoring to carry all they can, would only load still heavier. It has been estimated that an average two-horse team should be able to haul, on a level, 9,500 lb., including the weight of the truck. One ferry company weighed 200 heavily loaded trucks and found their average weight to be 16,000 lb. with a maximum of 20,000 lb.

CHAPTER VII

THE PASSENGER TERMINALS OF NEW YORK CITY

The railway passenger terminal situation in New York City is of peculiar interest to the student of railway problems. The city is not only the largest and busiest in the country, but it has grown so fast that the great railway systems which serve its people have been hard pushed to keep abreast of the demands upon their terminal facilities. Nor has their problem been lightened by the fact that the city proper is on the long narrow island of Manhattan accessible directly to but two of the great carriers involved, the New York Central and the New Haven. The terminals of the other carriers in New Jersey or on Long Island are separated from it by a wide stretch of river and only the Pennsylvania has thus far been able to secure a station on Manhattan physically connected by tubes with its properties on the Jersey shore or in Long Island City.

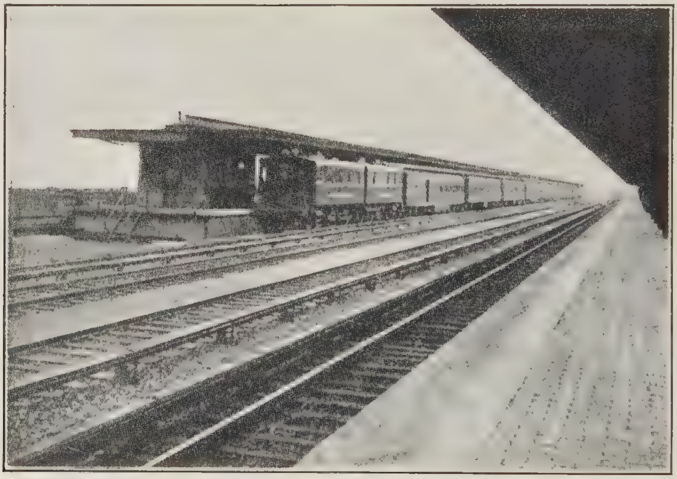


Fig. 108.—Manhattan Transfer, where trains to Pennsylvania Terminal change engines.

New York City is served by five important water front terminals. It contains in the Pennsylvania Railroad's new terminal the largest through station in the United States and in the Grand Central Terminal not only the largest head station in the country but the largest passenger terminal of any type in the world. The city is one of the very few in which passenger terminal electrification has been carried out to any great extent.

The water front terminals merit but a word at this place because the subject is treated more fully in Chap. VI. The five stations referred to are the Jersey City station of the Central of New Jersey used by trains of that road and those of the Philadelphia & Reading, the Baltimore & Ohio and the Lehigh Valley; the Pennsylvania and Erie stations, also in Jersey City; the Delaware, Lackawanna & Western station at Hoboken; and the West Shore station at Weehawken. Descriptions of the Jersey Central and the Lackawanna stations are given in the preceding chapter.

The Pennsylvania Railroad's terminal on Manhattan was opened for service on November 27, 1910. The station which, as has been noted, is the largest through station in the world, occupies a central position at the corner of Seventh Avenue and 31st Street, one block west from Broadway. It will be remembered in connection with this terminal that although the station structure is in itself a masterpiece of modern architecture, it is but part of that great project which gives the Pennsylvania on the one side of New York and the Long Island on the other direct access to the great metropolis. One will be reminded, too, that work is now nearing completion which will join the rails of the Pennsylvania with those of the New Haven and permit through movements of trains via New York from New England to points in the West and South.

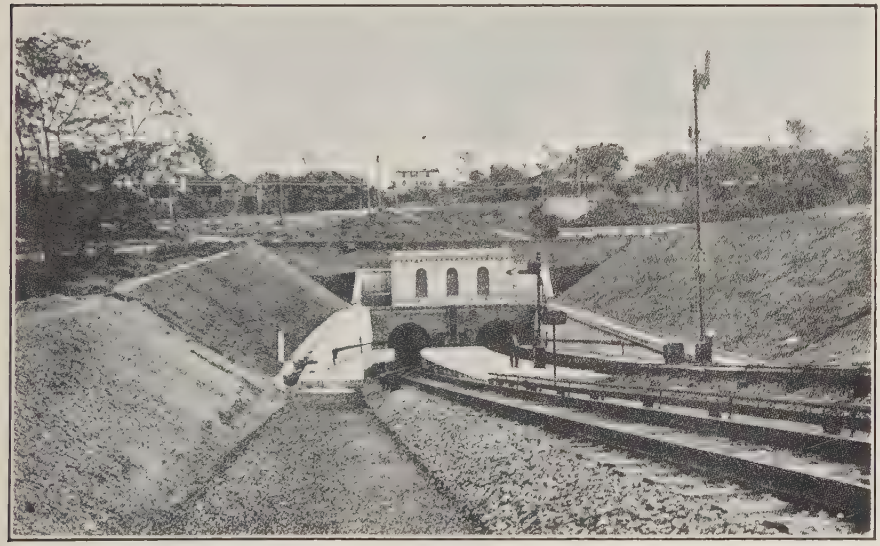


Fig. 109.—New Jersey portals of Pennsylvania tunnels.

The entire improvement of which the great terminal is a part extends from Manhattan Transfer, 1 mile east of Newark, N. J., and about 7½ miles from the terminal, to a connection with the Long Island near Woodside, L. I. Manhattan Transfer is the point where the line to the terminal branches off from the original line to the Jersey City station. It is also the end of the electrical division. Trains change here from steam to electrical operation and are hauled thence to New York by locomotives of the type shown in Fig. 187, operating with a direct current of 600 volts received from a third rail.

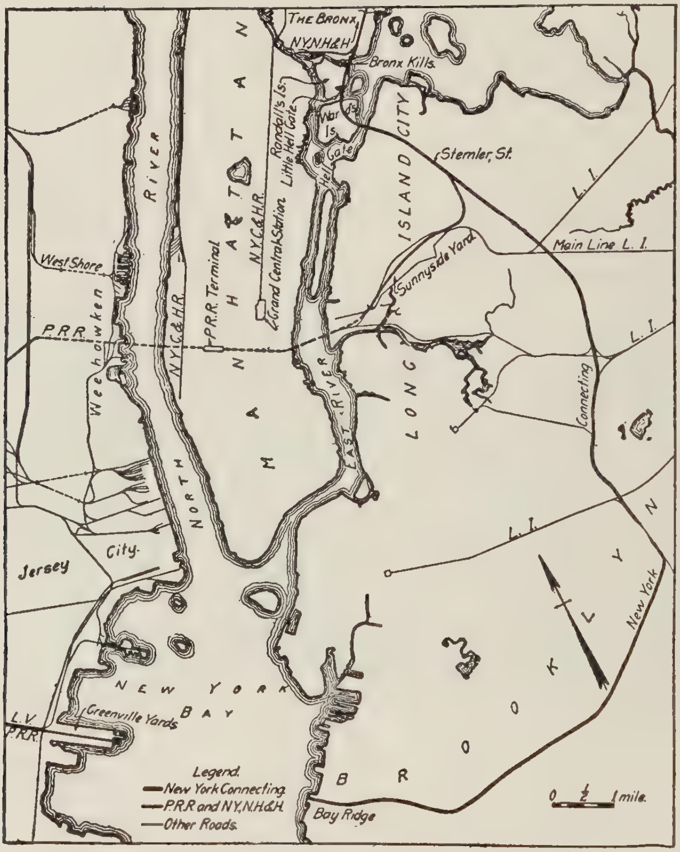


FIG. 110.—Map of New York Connecting.

From Manhattan Transfer a two-track line extends across the Hackensack meadows to Weehawken whence there are two tunnels beneath the North River to the station area on Manhattan. Under the East River on the other side of the city there are four such tunnels, two of which are used by Long Island multiple unit trains and two by Pennsylvania train movements to and from the great Sunnyside Yard just east of the portals on Long Island.

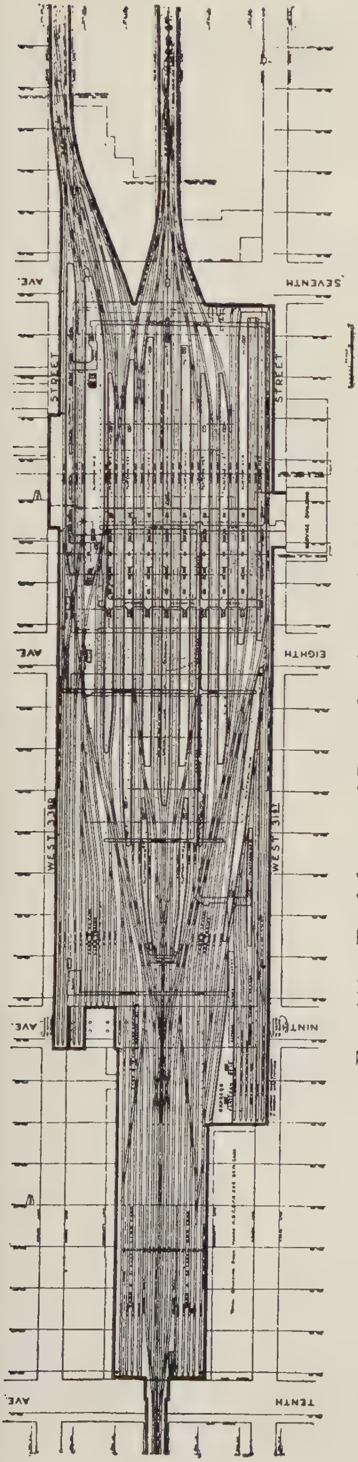


Fig. 111.—Track layout of Pennsylvania Terminal, New York.

A large part of the Pennsylvania Terminal's value will lie in the fact that direct connection will be made between its rails and those of the New Haven and thus those of New England. The New York Connecting Railroad is owned one-half by each the Pennsylvania and the New Haven. It will extend eventually from the latter's Harlem River Branch to Bay Ridge just opposite from the Pennsylvania's Greenville yards with a branch, if such it may be called, to Sunnyside Yard. This northern end of the line, the section of interest to us here, is now nearing completion. It consists of a line about 10 miles long leaving the Harlem River Branch at 142nd Street in the Bronx, crossing Bronx Kills to Randall's Island, and then Little Hell Gate to Ward's Island, turning sharply to the left and then crossing Hell Gate itself to Long Island on a bridge having the longest arch span in the world, connection being made with the terminal tracks at Sunnyside Yard. This line, a four track line, will cost no less than $10,000,000 or about $1,000,000 a mile, but it is expected that in the course of time it will be used by 40 passenger trains a day between New England and the West and South.

The Pennsylvania Railroad's New York terminal is now and probably will be for some time the greatest side station ever built. The station building proper occupies two complete blocks from Seventh Avenue to Eighth Avenue and from 31st to 33rd Streets. It covers an actual area of nearly 8 acres, the area of the entire terminal including the subterrannean yards being no less than 28 acres in which are laid 16 miles of track. When the terminal was built

100 houses, including several churches, were removed to make room for it and there were used in its construction 27,000 tons of steel, 15,000,000 bricks and 1,140 carloads of granite. The building is said to be the largest structure in the world devoted solely to the use and convenience of railway patrons, it being considered, of course, that the buildings of the larger and busier Grand Central Terminal are used for a variety of

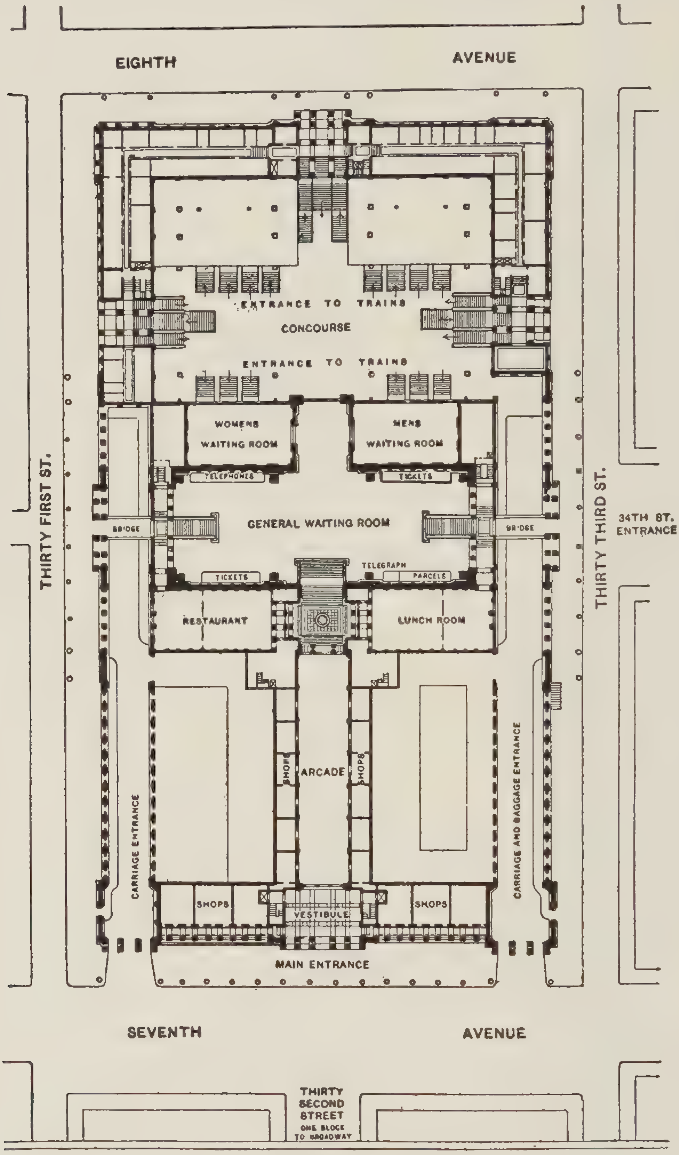


FIG. 112.—Street floor plan, Pennsylvania Terminal.

purposes. The frontage of the Pennsylvania Station on each of the avenues is 430 ft. and the maximum height is 153 ft.

Above the Doric columns of the Seventh Avenue facade—the main entrance—is an entablature surmounted by a clock 7 ft. in diameter, 61 ft. above the sidewalk. The main waiting room is reached through an arcade, 45 ft. by 225 ft., bordered on both sides by shops of very high grade. The arcade, at its inner end, expands into the loggia, a colonnaded hall, affording entrance to the dining room and café on one side and the lunch room and buffet on the other. A broad stone stairway leads directly into the general waiting room (see view, Fig. 9), the room being also accessible directly from the street. This is one of the largest rooms in the world, and measures 103 ft. by 277 ft., the distance from floor to roof being 150 ft. On its west side there are two subsidiary waiting rooms, each 58 ft. by 100 ft. in size, provided with seats and connected with retiring rooms and lavatories. Nearby, also, there is a fully equipped emergency hospital. The ticket offices are on the same level, there being two sets of windows, on diagonally opposite sides of the waiting room. The main baggage room is also adjacent, the counter being under the stairs leading down from loggia to the general waiting room. This baggage room also has 450 ft. frontage for the use of transfer wagons, and the baggage is delivered and taken away through a special subway reached via the carriage and baggage driveway sloping down from the carriage entrance at the corner of Seventh Avenue and 33rd Street. From the baggage room trunks are delivered to the tracks below by motor trucks and elevators.

Parallel to and connecting with the main waiting room by a wide thoroughfare is the concourse, a covered assembling place over 200 ft. wide extending the entire width of the station. This is the vestibule of the tracks since stairways descend from it to each of the train platforms on the track level. The concourse and adjacent areas are open to the tracks and form a courtyard 210 ft. by 341 ft. covered by a lofty roof of iron and glass. The concourse has entrances on all four sides and the traveler can reach it directly from Eighth Avenue or either of the streets without having to go through the waiting room.

The Pennsylvania Terminal is one of the very few in this country in which an attempt has been made to separate incoming from outgoing passengers. For the use of the former there is a second concourse between the main concourse and the train platforms. Incoming passengers mount the stairs to this level and can easily find their way to other parts of the station or the streets without interfering in any way with the patrons moving through the station to board outbound trains.

The 11 train platforms below this auxiliary concourse serve 21 tracks and provide 21,500 sq. ft. of platform space. These platforms are connected by stairways with the two concourse levels above. They are of concrete and are built level with the car floors, the Pennsylvania Railroad having been the pioneer in America in introducing this idea in railroad passenger terminal design.

The interior of the station is most imposing. The public rooms are open to the roof. The lofty walls of mellow travertine are unbroken by galleries or protrusions of any kind, but their beauty is magnified at intervals by Ionic and Corinthian columns. The only touch of color is given by a series of large maps inclosed within panels high on the walls and ceiling. Daylight pours in through huge semicircular windows high above the floors and through skylights set in the roof. At night illumination is furnished by bracket lights, electroliers and a number of handsome standards surmounted by groups of incandescent bulbs.

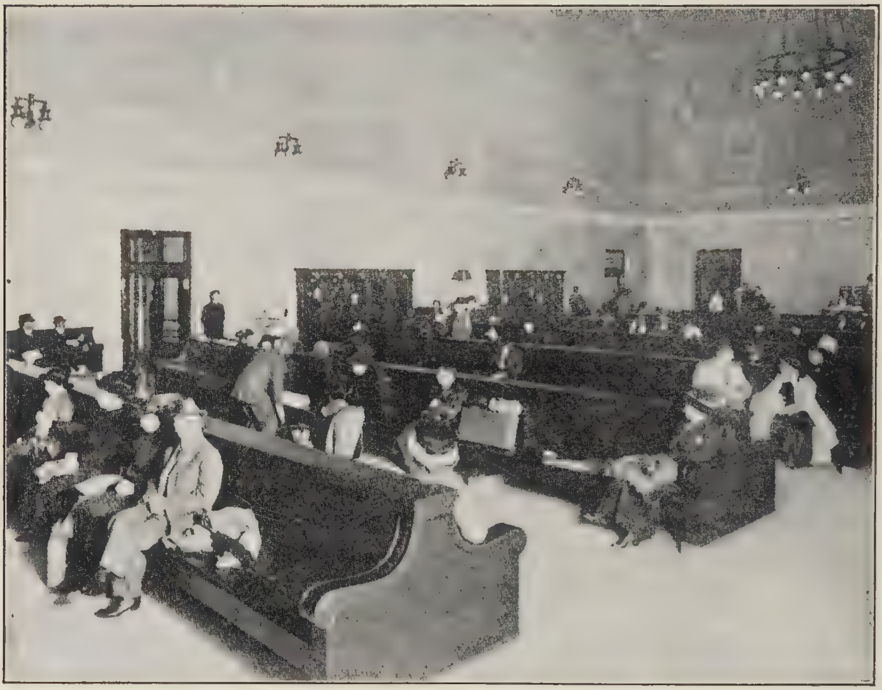


Fig. 113.—Waiting room, Pennsylvania Station, New York.

As the station is operated at present, trains of the Pennsylvania Railroad proceed from the west side of the Hudson River through one of the two single track tubes under the river to the terminal. After discharging its passengers, each train proceeds through one of the four tunnels under the East River to the Sunnyside Yard in Long Island City where it is broken up, cleaned and stored. The station tracks are thus left free of idle equipment. The westbound through trains made up at Sunnyside Yard, on the other hand, move empty to the station, take on passengers there and then move onward under the Hudson to Manhattan Transfer and beyond. As yet there are no through trains carrying passengers through the terminal and its tunnels from New Jersey to Long Island although, as has been noted above, such service is planned for the near future.

The Long Island trains use eight of the station's tracks, but the Long Island patrons are served by a separate waiting room, concourse and ticket office, these facilities being reached from the street by the passageway at the corner of Seventh Avenue and 33rd Street.

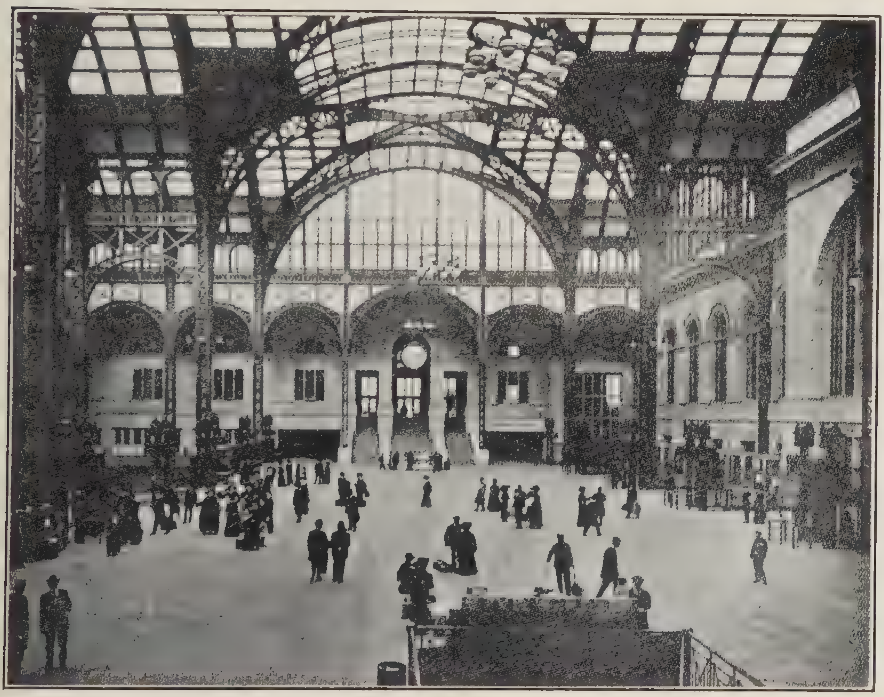


Fig. 114.—Concourse of Pennsylvania Station, New York.

A few detailed statistics may be of more than passing interest. The highest point of the tracks is 9 ft. below sea-level or mean high water. There are 25 baggage and express lifts. Three million cubic yards of excavation were required; 7,800 lineal ft. of retaining walls were built and 4,400 lineal ft.—about 8 acres—of streets and avenues carried on bridging. The loading per square foot on avenue bridging is 1¾ tons; the maximum loading per square foot on bridging east of Seventh Avenue, 5 tons. The maximum capacity of all tunnels is 144 trains per hour. The station yard tracks have a storage capacity of 386 cars. The initial service was about 1,000 trains a day[1] divided, 40 per cent. Long Island and 60

[1] The present service is much less than this. See page 194.

per cent. Pennsylvania Railroad, and, as noted elsewhere, the entire service was represented by "dummy" trains for a week before the tunnels were opened, each train being run with the same number of cars, on regular schedule, as though performing regular service. Train sheets were kept, delays recorded, and everything possible done to put things in smoothly working order.

There can be no doubt that the Pennsylvania System built a truly wonderful city gate for its entrance into New York City. Nevertheless, although it is the consensus of opinion that the station is a remarkable edifice from many points of view, the terminal has not been let alone by critics. The Interstate Commerce Commission, itself, spoke of the station in its report in the Anthracite case (35 I. C. C., 270) under the head of Unproductive Betterments in the following words:

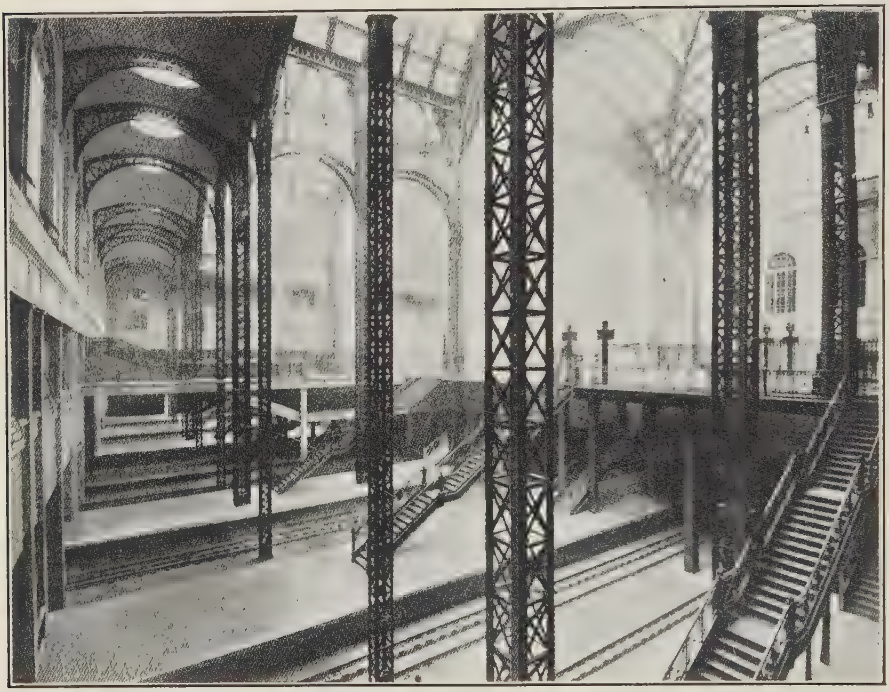


FIG. 115.—Train shed of Pennsylvania Station, New York.

> The Pennsylvania has expended on its new passenger terminal properties in New York City approximately $114,000,000. These properties are operated by the Pennsylvania Tunnel & Terminal Railroad Company, and the operations result in deficits each year. The deficit in the year ended June 30, 1913, was $2,087,000. The record shows that the terminal was constructed for the benefit of the Pennsylvania lines west of Pittsburgh as well as the lines east of Pittsburgh, but no part of its cost is, by the carrier, assigned to the income of the lines west of

Pittsburgh. In the statements of investment and income the deficit is charged to the income of the Pennsylvania Railroad (the lines east of Pittsburgh), and the per cent. of net operating income on the investment for the Pennsylvania Railroad is substantially reduced because of these deficits and the large investment in this terminal property. The record shows that when the New York Connecting, now under construction, is completed the terminal properties will some time in the future be used for passenger traffic between the Pennsylvania lines and the New Haven. Thus the question is presented: Must the present effective freight rates of the Pennsylvania earn an annual return of 6 per cent. on the investment in these passenger terminal properties? The record shows that $47,000,000 of the expenditures in this property has been charged to profit and loss and to income of the Pennsylvania; that is, its past surplus income has already contributed $47,000,000 to the cost of this property.

A great many laymen, however, have also spoken. The average traveler will be dumfounded when he views the magnificent waiting room and concourse for the first time, but in more cases than a few the immensity of things and the magnificence will lose their luster when he has traversed the "magnificent distance" from the sidewalk to the train or *vice versa*. It cannot be denied that this is a disadvantage which was not overcome in the planning of the station.

Although the terminal is but little more than a block's distance from Herald Square, one of New York's busiest centers, some criticism has been offered because of its relative inaccessibility. Considerable has been said also about the slow development of property about the station. The approaching completion of the Seventh Avenue subway; the Pennsylvania's announced purpose of building large and high grade hotel adjacent to its station, and other developments, now in progress, should easily disarm all criticism of this kind.

The Hudson Terminal of the Hudson & Manhattan at 30 and 50 Church Street is really a rapid transit station, but it partakes of so much that is good in passenger terminal design that it merits at least a brief description. The Hudson & Manhattan, itself, enters New York City via two lines each operating through two tunnels under the North River. There is a main line from Newark, N. J., about 8 miles out, which, running parallel to the Pennsylvania Railroad's line to Jersey City and connecting with it at Manhattan Transfer, divides at Jersey City, one branch running under the river and uptown under Sixth Avenue to 33rd Street and the other directly across to the downtown station which we are here to consider.

The Hudson & Manhattan operates multiple unit trains receiving direct current from a third rail. These trains carry patrons to the Pennsylvania and Erie Stations in Jersey City and to the Lackawanna Station in Hoboken. The service has proved superior in a great many ways to that of the ferry boats which formerly handled the traffic exclusively. A carefully timed service is also run to Manhattan Transfer where exact connection is made with Pennsylvania trains from the Pennsylvania Terminal.

The Hudson Terminal occupies a position fronting on Church Street, one block west of Broadway, between Cortlandt, Dey and Fulton Streets.

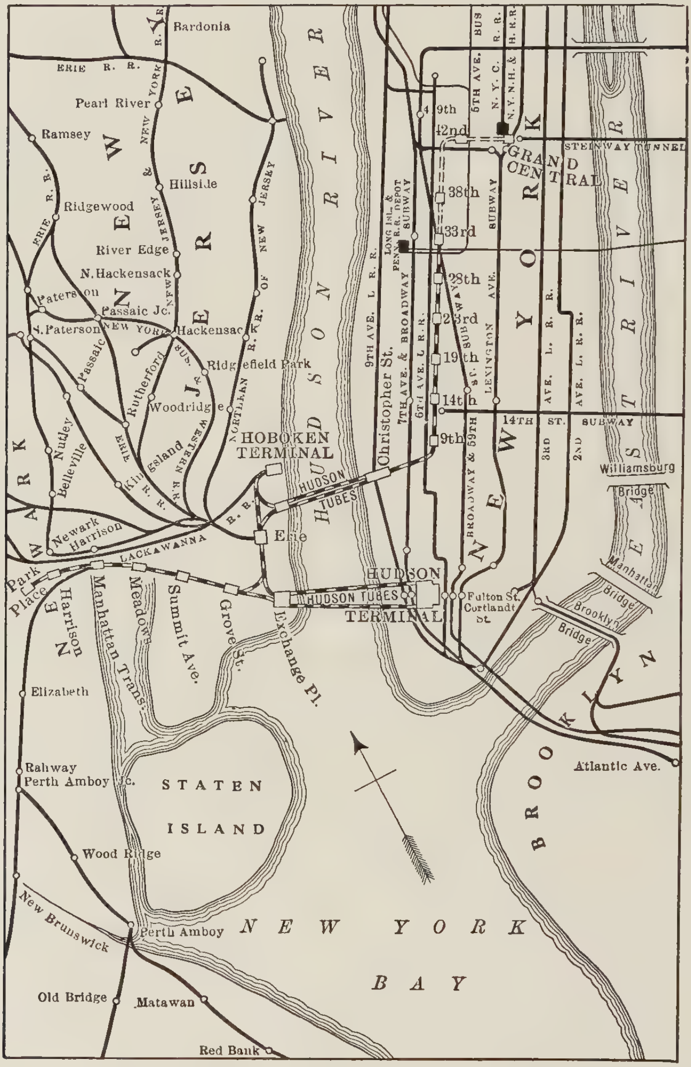


FIG. 116.—Map of Hudson & Manhattan R. R.

That part of it above street level forms two 22-story office buildings, designated respectively 30 and 50 Church Street, which as is well known are two of the busiest and most convenient office buildings in New York City.

The station, itself, is entered directly from entrances on Cortlandt, Dey and Fulton Streets. The concourse is one level below the street, there being ramps at either end in place of stairways. The room extends the entire width of the property and is nothing else than a great arcade containing all sorts and kinds of booths and stores. It is very brilliantly lighted and its attractiveness brings many visitors and buyers who do not go out in trains. On one side of the room there are ticket offices of the Pennsylvania and the Erie, toilet rooms, telephone booths and a room for ladies.

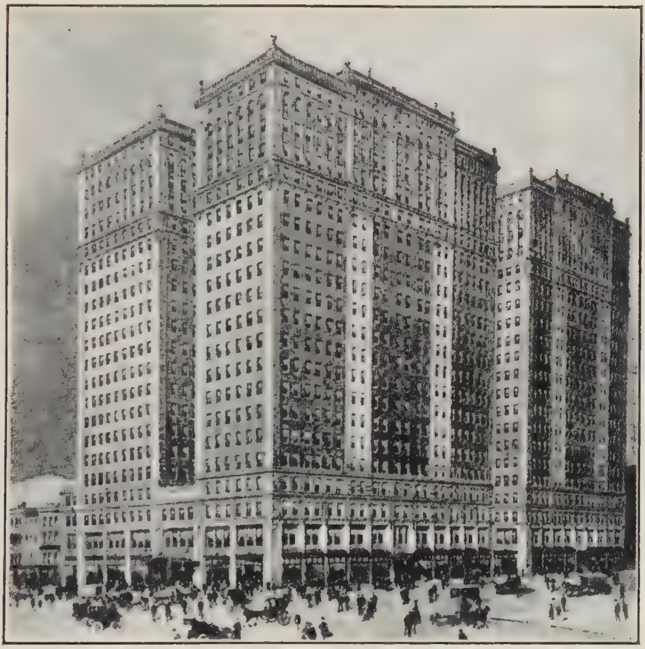


FIG. 117.—The Hudson Terminals at 30 and 50 Church Street, New York.

Access to the tracks and train platforms is given by stairways leading down to the level below. There are five tracks, each on a loop and trains are loaded from one side and unloaded on the other. At present there are under the North River two tunnels to this station but plans are made to add at some future time two more.

The Grand Central Terminal is not only a station; it is a monument, a civic center or, if one will, a city. Without exception, that part of it which is the station is not only the greatest head station in the United States but the greatest station of any type not only on this continent but in the world.

The terminal is the latest stage in a growth which began in 1832 when the New York & Harlem began to use a terminal on Center Street, near City Hall. The trains were drawn by locomotives south to 14th Street only and from there by horses. By 1857 the growth of the city uptown had been so great that a new station was built at 26th Street and Fourth Avenue on the site of Madison Square Garden. In that same year, also, the use of steam locomotives south of 42nd Street was discontinued. The consolidation of the New York Central and the Hudson River Railroads in 1869 led to the construction of the third terminal on the present site on 42nd Street. This station, opened October 7, 1871, was, in the words of the New York Tribune, "By far the largest, stateliest, most costly and commodious edifice devoted to like purposes on the continent, an ornament to our city and a credit to our architecture." It occupied 4 acres of ground and its 600-ft. train shed, covering 15 tracks, was with its single arch span of 200 ft., the largest yet built at that time in the country. This station served its purposes until 1899 when it was enlarged. The terminal officers soon saw, however, that even the enlarged terminal was wholly inadequate for the rapidly growing traffic. That, coupled with the fact that conditions in the Park Avenue tunnel were already intolerable, led in 1902 to the decision that the terminal must

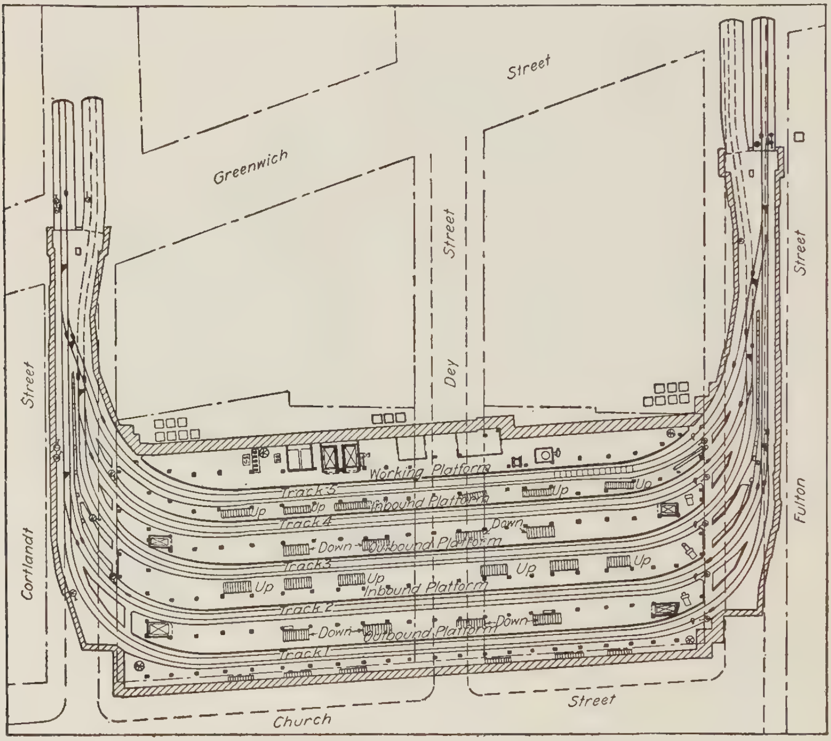


FIG. 118.—Track layout of the Hudson & Manhattan Station.

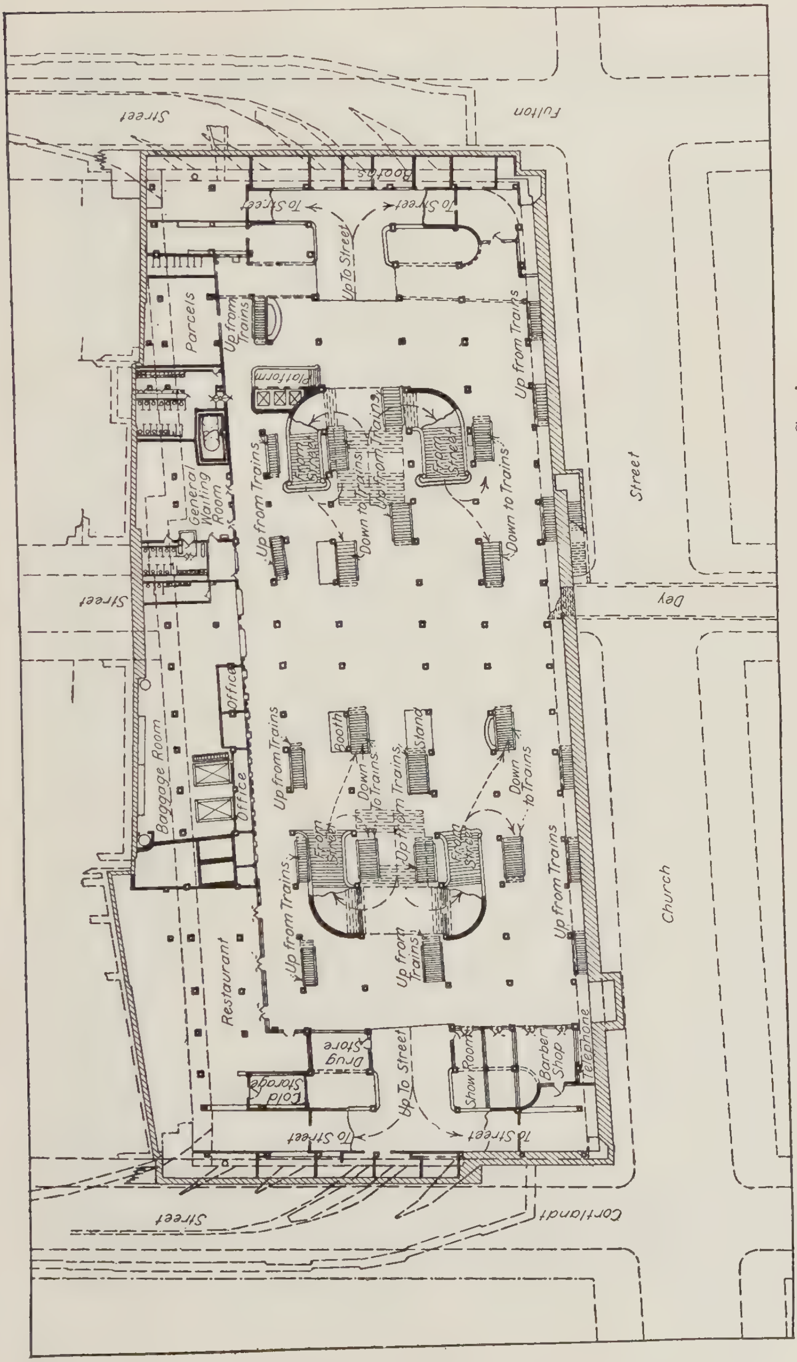


FIG. 119.—Plan of concourse—Hudson & Manhattan Station.

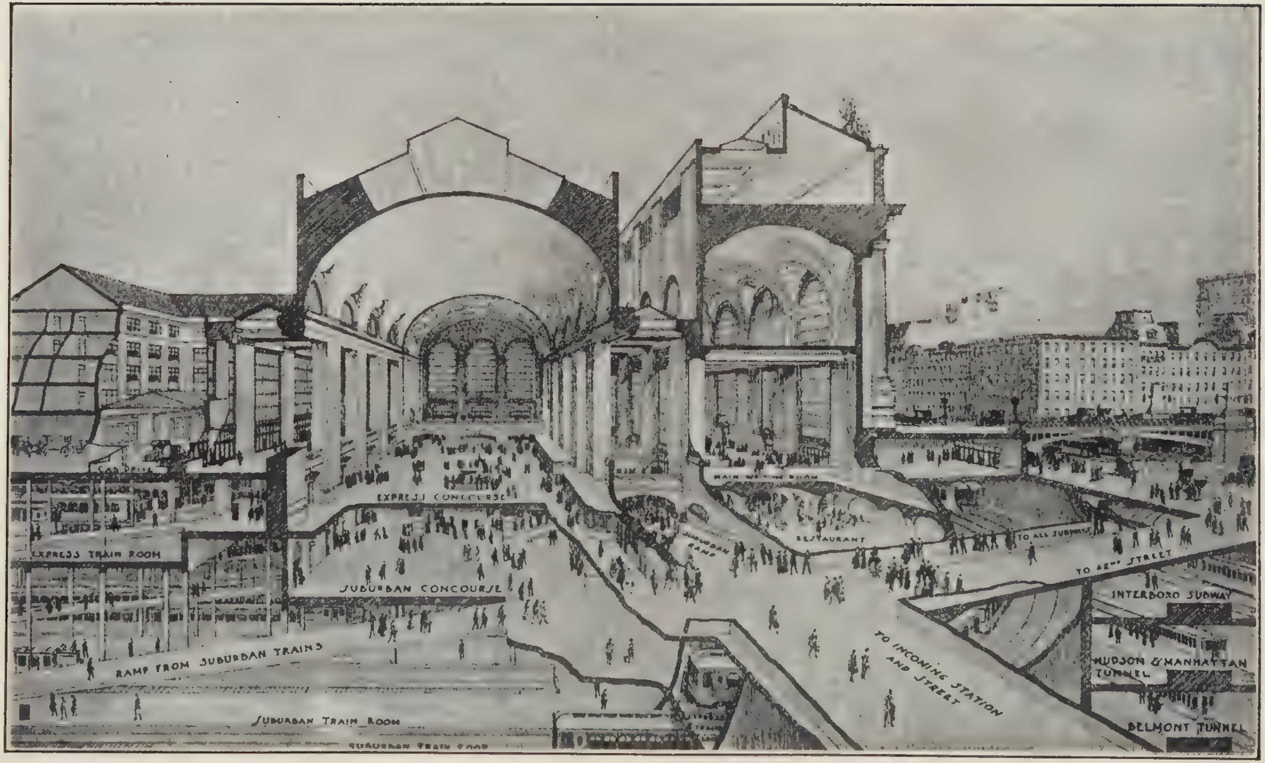


FIG. 120.—Cross sectional view of Grand Central Terminal.

be rebuilt, rebuilt with an eye to the future and rebuilt for electrically operated trains. New plans were already under way when legislation was passed in 1903 requiring the substitution of electricity for steam.

The extensive plans drawn up included:

1. The depression of the approach tracks from 57th and 42nd Streets and the depression and enlargement of the terminal yard.

2. The erection of the new terminal.

3. The construction of the "Marble Hill cut-off" and the Spuyten Duyvil rectification near King's Bridge.

4. The depression of the Port Morris Branch and the elimination of grade crossings.

5. The elimination of all grade crossings and the making of special station improvements in the electrical zone.

6. The four tracking of the Hudson and Harlem divisions.

7. Electrification.

The plans approved by the Board of Estimate and Apportionment of New York City in 1903, with certain changes made with its approval later, called for a two-level terminal, with all its tracks below the level of the streets. They meant the restoration of all cross streets from 45th to 56th Streets, between Lexington and Madison Avenues, the extension of Park Avenue at its full width of 140 ft. from 59th to 45th Streets, and the restoration altogether of 4,500 ft. of city streets to public use. The railway retained for railway purposes only the subsurface rights below the streets. The remainder of the area over its great yards it planned to use for buildings, including office buildings for itself and others, two hotels, apartment houses, clubs and theatres. Besides adding the immense value of this area and these buildings to the city the railway will receive a truly enormous revenue which will more than pay the interest charges on the great terminal.

Construction work was started on the station in August, 1903. The station was opened on February 1, 1912 and the last track in the old terminal taken out of service on June 21, 1912.

As has been stated the terminal has two levels. The upper one of these, 20 ft. below the street, is 46.4 acres in area and has 19.5 miles of track. There are 42 tracks, and 29 of these are adjacent to platforms for a total distance of 28,850 ft. When the station is completed, trains will come in on the five westerly tracks, unload and loop. The storage yards will eventually have a capacity of 1,050 cars so that all cars may be cleaned and stored at 42nd Street, the light movements to and from Mott Haven yard thus being made unnecessary. The upper level has three storage yards, tracks 1 to 11, inclusive, being meant alike for baggage, mail, express and storage.

The lower or suburban level, about 44 ft. below the street, has 14.1 miles of track and an area of 32.8 acres. Its tracks are 25 in number, 17 being adjacent to platforms a total distance of 13,000 ft. On this level there are two loops, the inside one of which, of 136 ft. radius, is meant for multiple unit equipment. There are two storage yards and in them only light cleaning will be done. The approaches to this level leave the upper level tracks between 53rd and 55th streets, the inbound rails being on a descending grade of 3 per cent. and the outbound on an ascending grade of 2.7 per cent.

The station's 30 platforms serving 7.9 miles of track are all of concrete. They are 4 ft. in height above the top of the rails and have a minimum width of 15 ft.

The station building proper fronts on 42nd Street at Park Avenue and extends back to 45th Street. It is a truly massive structure, 673 ft. long, 301 ft. wide, with seven stories but with provision for 13. The base and lower portion of the edifice are of Stony Creek granite with Bedford limestone above. Fronting on 42nd Street there are three large arched windows, surrounded by massive pillars and surmounted by a large statuary group about a clock.

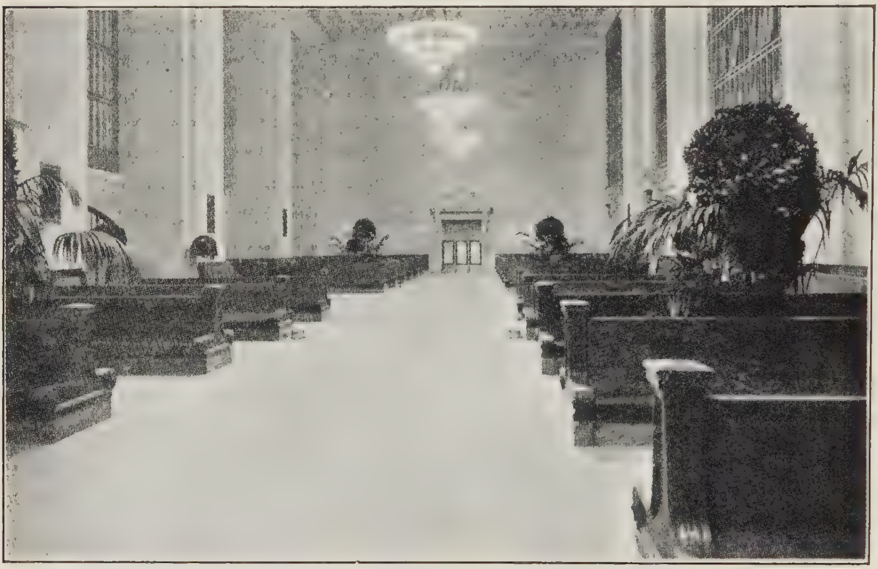


FIG. 121.—Waiting room, Grand Central Station.

This imposing front (shown in Fig. 10) can be clearly seen from Park Avenue. Provision has been made for continuing that avenue on an overhead structure across 42nd Street and around the station.

The principal entrances to the station are four in number. They are situated as follows: at the corner of 42nd Street and Vanderbilt Avenue; at the southeast corner of the station on Depew Place; in the center of the front opposite Park Avenue; and from the subway. There are also entrances from 43rd Street on Depew Place and Vanderbilt Avenue, the former entering the main concourse directly and the latter by the gallery.

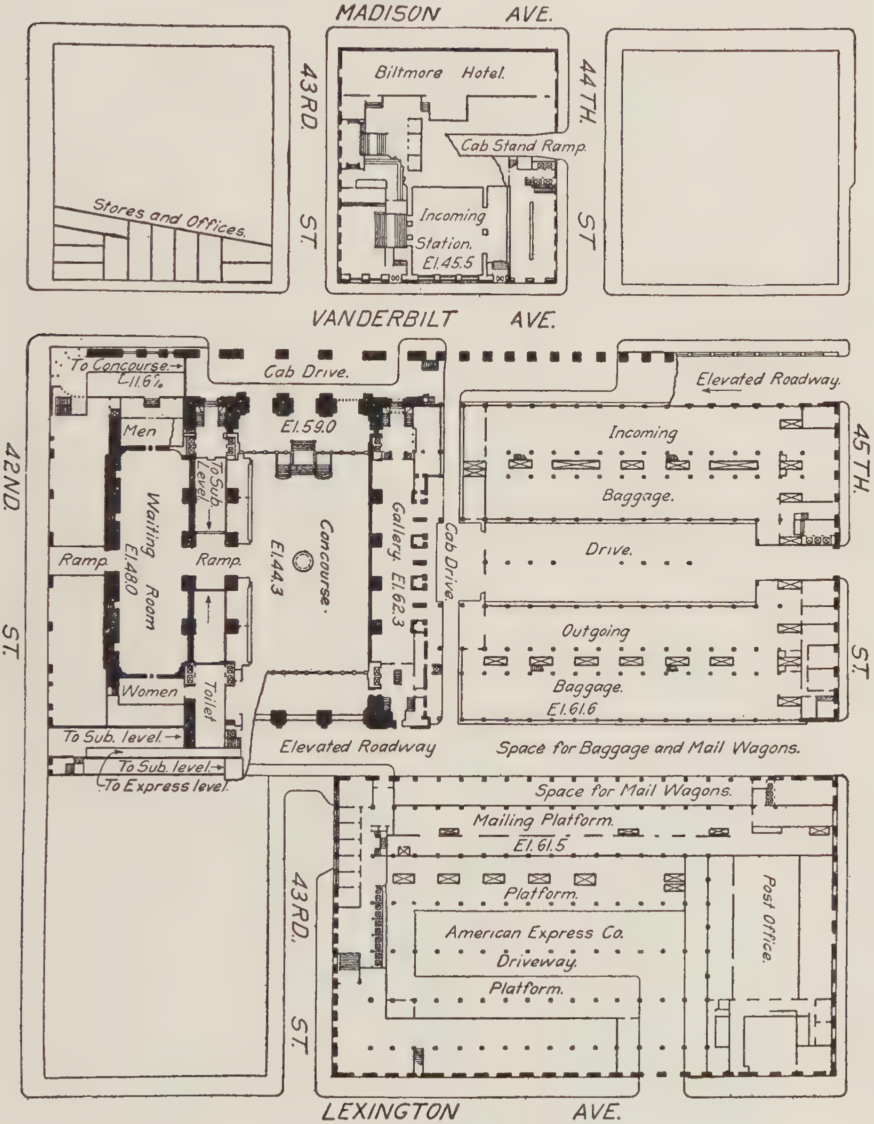
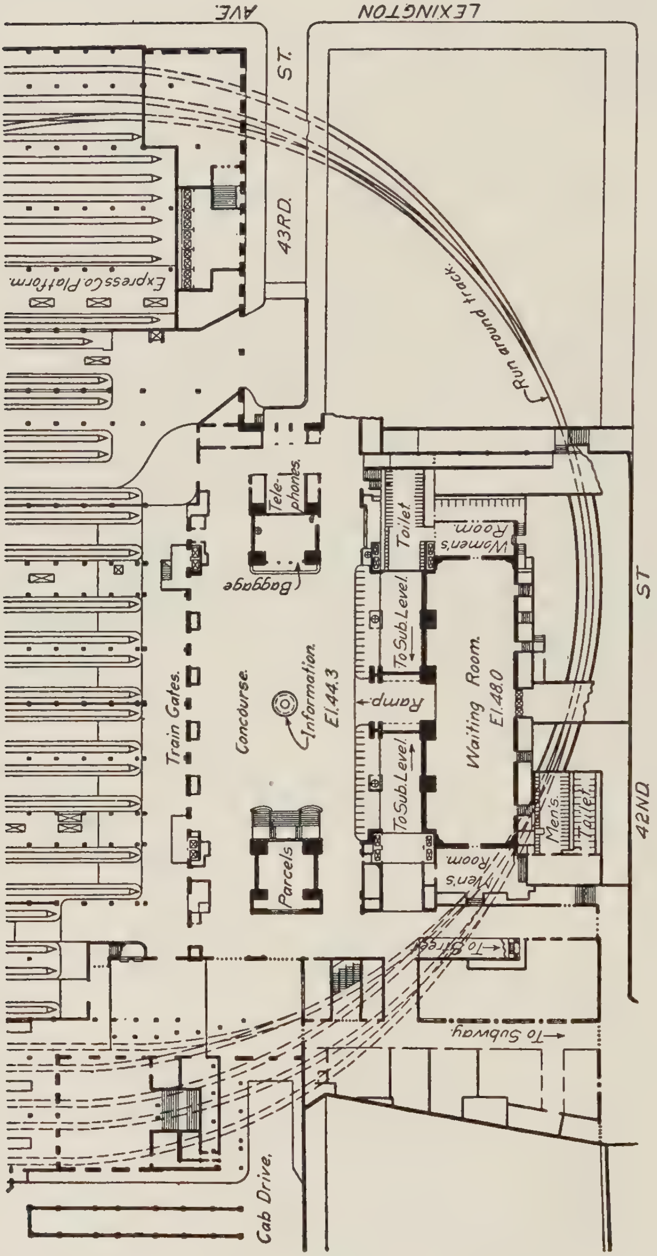


FIG. 122.—Floor plan of Grand Central Terminal, Street level.

A person entering the station from the center entrance on the 42nd Street front passes through a short vestibule and down a ramp to the main waiting room, 65 ft. by 205 ft. in size and 3½ ft. below the street. This room is finished in buff stone and marble. It has an artistic beamed


LEXINGTON
AVE.
43RD. ST.
Express Co. Platform.
Run around track.
Tele-phones.
Baggage
Toilet
Women's Room.
ST
To Sub. Level.
Ramp.
Waiting Room.
El. 48.0
Train Gates.
Concourse.
Information.
El. 44.3
To Sub. Level.
Parcels
Men's Toilet
Men's Room.
42ND
To Street
To Subway.
Cab Drive.

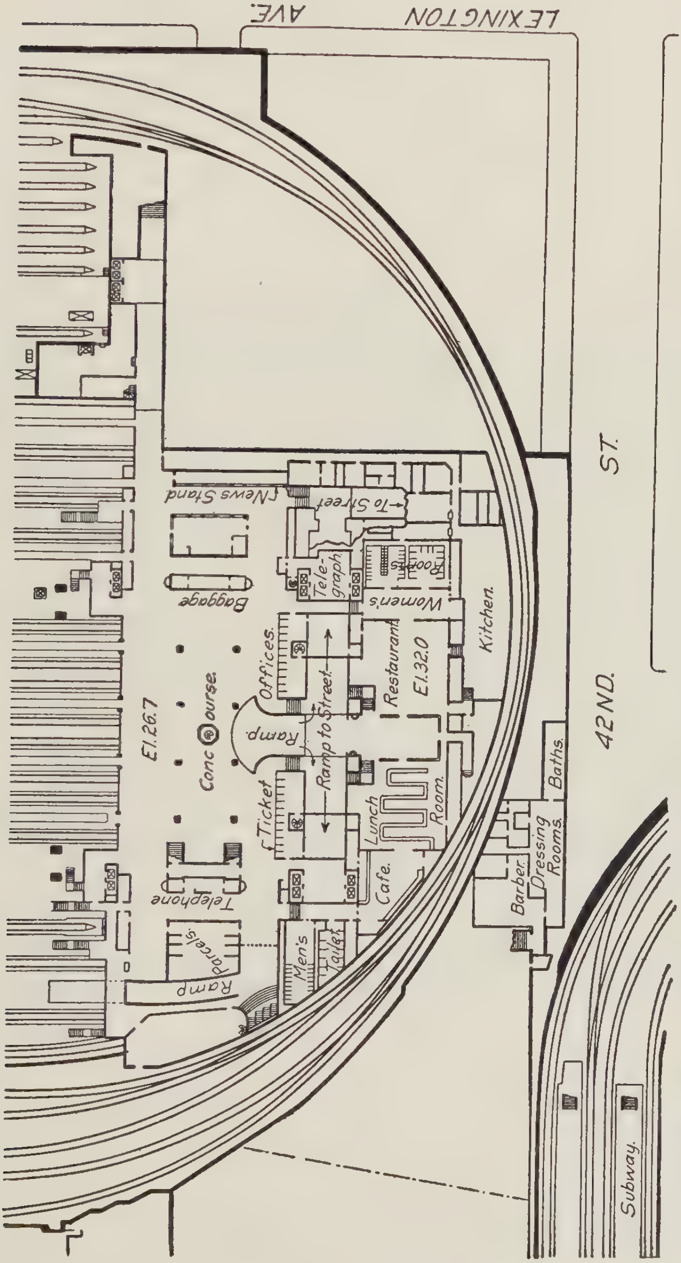


FIG. 123.—Floor plant of Grand Central Terminal, express train concourse and suburban concourse levels.

ceiling, and is lighted by five large electroliers. The room is provided with seats; at the west end of it is the men's room with its pay and free toilets attached and at the opposite end the women's room.

The express train concourse occupies a central portion of the station and is its main feature. The room is of magnificent size and style and, like the city which its station serves, strikes the stranger with awe. Located just north of the main waiting room it is 3 ft. 9 in. lower and is connected with it by a ramp. The room is 287 ft. long, 120 ft. wide and 125 ft. high at its highest point; it has further extensions under the gallery at the east end of 105 ft. and under the gallery and street on the opposite side of 55 ft. It is finished in Botticino marble and buff-tinted stone, and light is supplied by day through three large arched windows facing on Depew Place and one on Vanderbilt Avenue.

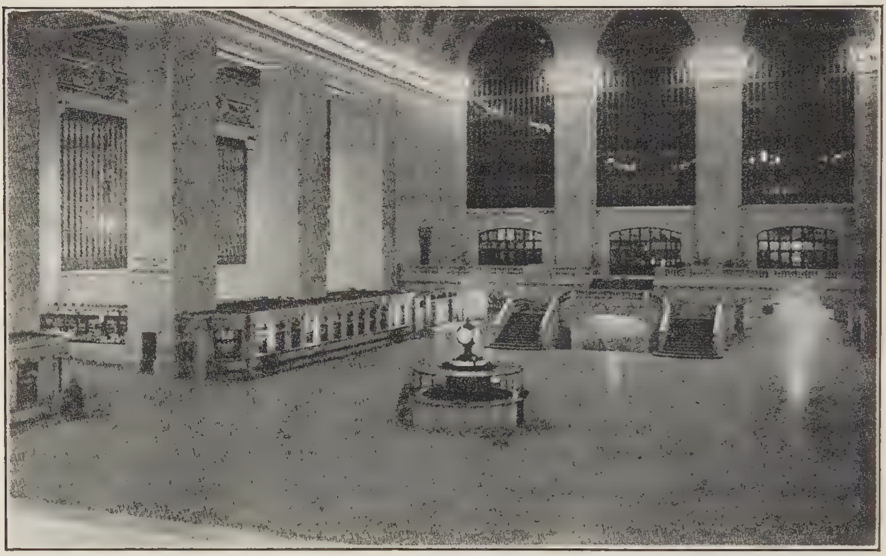


Fig. 124.—Night view of express level concourse, Grand Central Station.

The room, as handsome as it is by day, is better still by night. It is then that the arched turquoise-blue ceiling shows at its best. Upon the latter is depicted that section of the heavens seen from October to March or from Aquarius to Cancer. All the stars and constellations appear in proper order and of the stars in the greater constellations no less than 63 are lights.

In the center of the concourse is an octagonal counter, the information bureau, surmounted by an illuminated clock with four faces. On the right and left as one enters from the waiting room are the ticket offices respectively of the New Haven and the New York Central, each having 14 windows on the concourse. On the east side of the room there is a baggage counter. About the room on three sides there is a gallery with a wide stairway on the Vanderbilt Avenue side leading down into the concourse. From this gallery a fine view may be obtained of the beauties of the concourse.

Below the express concourse there is a similar facility for suburban patrons. This room is 70 ft. wide and like its counterpart upstairs has an information room in its center and ticket offices on one side, these facilities being in each case directly below the similar facilities above and connected with them by spiral stairways. The upper concourse has no seats but there are a few provided on the lower.

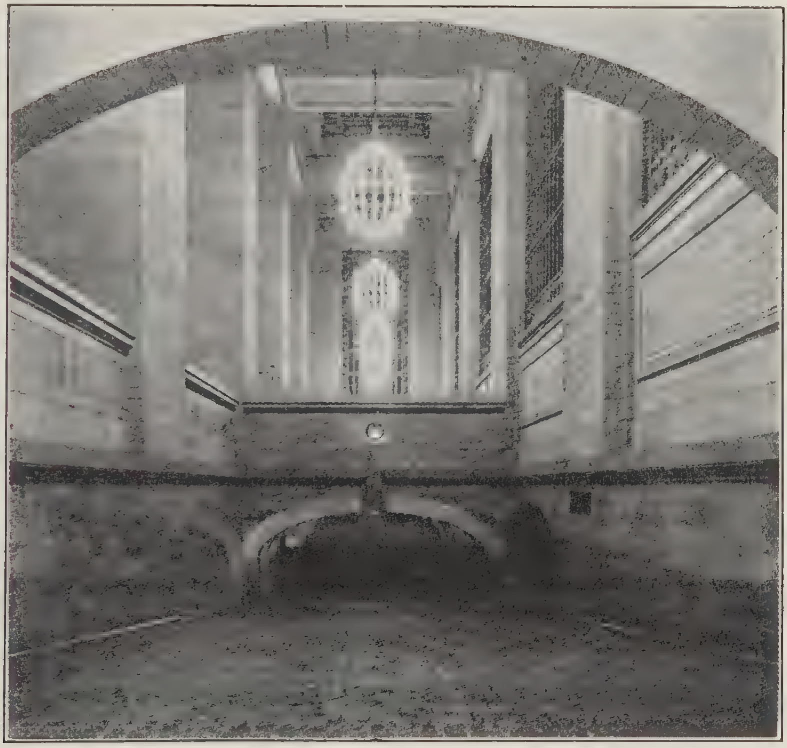


FIG. 125.—Ramps to suburban concourse, Grand Central Station.

Adjacent to the lower concourse and below the waiting room there are provided a restaurant and a lunch room.

The Grand Central Station is noted for its ramps. It has been estimated that 80 per cent. of those who will use the station will come and go on the subway and will not have to use the waiting room. As the express concourse is on the level with the mezzanine of the Interborough subway no ramp is necessary there. From the entrances on 42nd Street, however, long ramps lead down to the upper concourse and also to the lower one so that only in a very few cases must one go up or down by stairs. Great care was taken to secure the proper slope on these inclines, so that most of them do not exceed 1 ft. in 10.

The entire approach to the two concourses is in the nature of an arcade. Every available inch of space along the corridors and passageways has been used for stores and booths. The idea has many advantages. The sites are of the best and most desirable. The owners of the terminal planned wisely because the revenue from these concessions is no small sum.

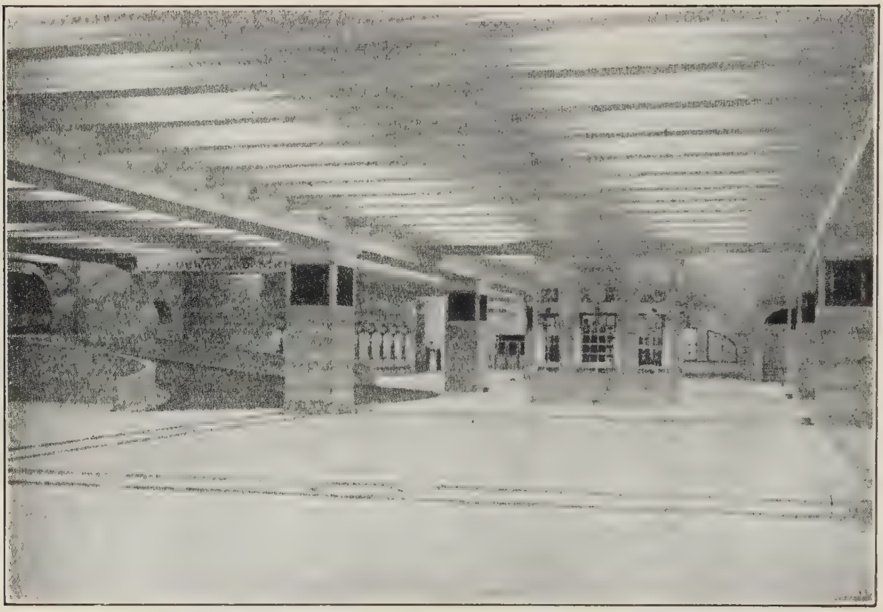


Fig. 126.—Suburban concourse, Grand Central Station.

Baggage is handled in a room fronting on 45th Street north of and 17 ft. higher than the main concourse. It is directly over two wide platforms on the express level designed for solid baggage trains. It can be entered either directly from 45th Street or by a driveway from Depew Place. Outbound baggage is unloaded either along the platform facing on Depew Place or from the enclosed interior driveway. Passengers with baggage coming to the station by carriage receive a claim check for their baggage at the cab stand, and they can exchange this check at the regular baggage office on either the main or suburban concourses for a regular check. Ten elevators are provided in the outward baggage room and nine in the incoming room, some of which are so spaced that baggage can be lowered directly in front of the different cars in a solid baggage train along the special baggage platforms referred to. When baggage is not

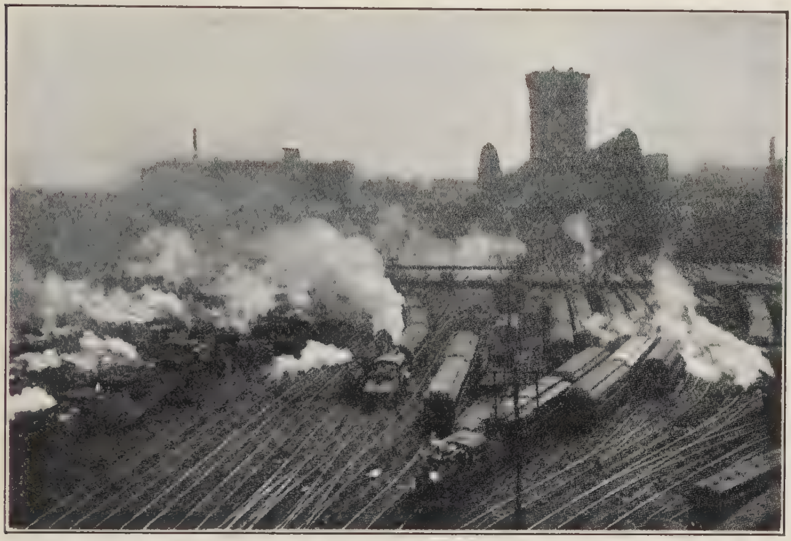


FIG. 127.—Grand Central Terminal yards before electrification.

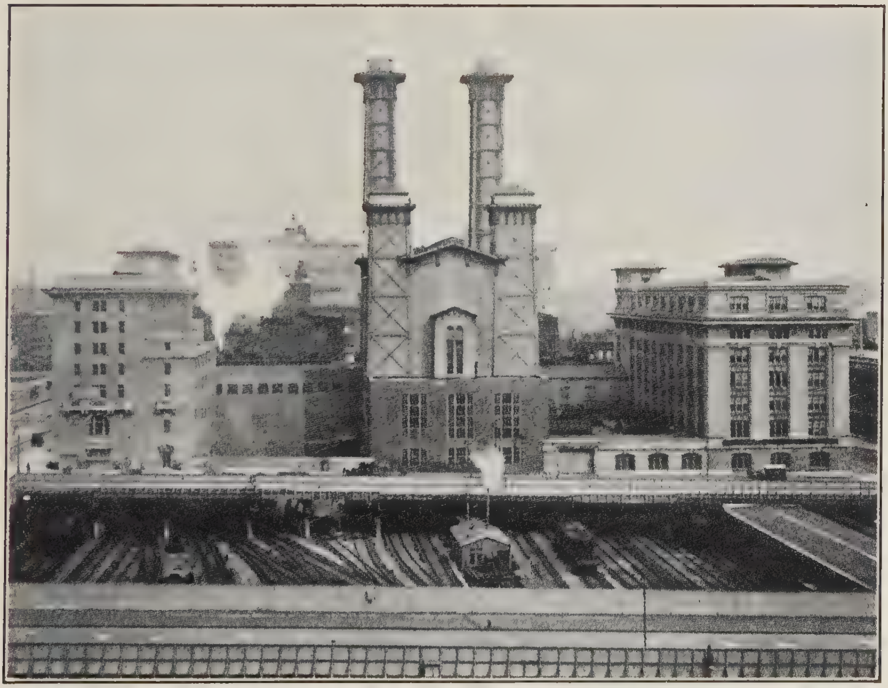


FIG. 128.—View of power house, Grand Central Terminal, and the yards after electrification.

destined for such a train, but for one of the regular passenger trains it is lowered by elevators to a transverse subway running beneath the tracks of the lower level near 45th Street, carried through this subway to the proper platform and raised to the track level by another elevator. Incoming baggage is lowered to a subway near 43rd Street and taken to the baggage room.

The mail and express facilities are on the opposite side of Depew Place, the mail driveway being recessed back from that street to avoid interference with baggage wagons. Six elevators lead to platforms below for solid mail and express trains while such traffic for regular passenger trains is handled in the same way as baggage.

CHAPTER VIII

TRACKAGE AND TERMINAL AGREEMENTS

The so-called "tripartite" agreement between the New York Central, the New York, New Haven & Hartford and the New York & Harlem Railroads covering the operation of the Grand Central Terminal in New York City, the approaching tracks, the Mott Haven equipment yards and attendant facilities, is especially interesting. It covers what is perhaps the most intricate operating problem in the world, for it relates to the service of two electrified steam railway lines operating under different systems (one using the third rail and direct current and the other the overhead contact wire and single-phase alternating current) and is based on a number of preceding leases and agreements, all of which were drawn up by able lawyers and operating men after a vast amount of study and adopted only after innumerable conferences.

In 1848 the New York & Harlem Railroad entered into an agreement with the New York, New Haven & Hartford whereby the trains of the latter were to enter the city of New York on the rails of the former company. This agreement superseded a former one made on January 22, 1846, and was to continue during the terms of the respective charters of the two roads. Other agreements and awards relating to compensation followed from time to time until the "tripartite" agreement of November 1, 1872 came into existence. The latter has since been modified by four supplementary agreements, dated respectively, December 31, 1885, July 14, 1897, August 17, 1898, and March 23, 1899, and by the lease from April 1, 1873, to April 1, 2274, of the New York & Harlem, including the Grand Central Terminal to the New York Central Railroad "subject to provisions of said contract of March 17, 1848."

The agreement now stands in this form: There is first a description of the properties involved including references to various schedules showing these properties in detail. There then follows that portion of the agreement whereby the New York Central, acting for itself and the New York & Harlem, arranges for the joint and equal use of the terminal for passenger traffic—providing that the New York, New Haven & Hartford's right to such use shall in no event exceed fifty (50) per cent. of the terminal's maximum capacity and that the New Haven's proportion of fixed charges (including interest at 4¼ per cent. on expenditures for acquisition of land needed for the construction of the terminal, charges for repairing, rebuilding or changing any part of the terminal made necessary "by act of God, fire, civil commotion, violence, casualty or operation of law," by compliance with certain agreements with or permits by the president of the Borough of Manhattan or resulting from any other changes in or additions to the terminal to which the New Haven assents in writing) shall in no event be less than $160,179.92 in each year—roughly, one-third the total payable annually. The New Haven further agrees to pay the New York Central a *proportion* of the annual net payments required by the terms of agreements with the city of New York and of all premiums for insurance, taxes and assessments which may be levied on the terminal, division to be made "between the parties occupying the same in proportion to the value of the use of the part so occupied"—payments to be made quarterly. The New Haven also agrees to pay the New York Central for its share of the net cost of maintenance, repairs and renewals of the terminal; of net expenditures for operation; of net expenditures "to contest, settle or pay claims, actions or judgments, for loss of or damage to property or for injury to or for the death of persons (except loss of or damage to the equipment of the parties hereto, any such loss or damage being provided for in Section 16[1] hereof) caused by the acts or omissions of the Terminal Manager, his agents or servants while engaged in the maintenance or operation of the Railroad Terminal; agents of the Terminal Manager, as used in this paragraph, means agents and servants employed by the Terminal Manager for the purpose of performing the duties imposed upon him by this agreement; such claims, actions or judgments may be settled by the party against whom such claim is made, action is brought or judgment is rendered when authorized in writing by the other party." These items are made payable 30 days after the New York Central renders its bill. That part of these expenses which is to be paid by the New Haven is based on the proportion which its use of the terminal bears to the entire use—"use to be based upon the number of cars and locomotives, excepting those performing Railroad Terminal service entering the said Railroad Terminal. For the purpose of this computation, each car and each locomotive shall be counted each time it shall enter the Railroad Terminal, including the cars of each company hauled from Mott Haven yard, or other exterior storage yard, but not including the locomotives performing such haulage service." Expenditures for switching and preparing cars for service, or for special service are not included.

The fixed charges involved in the existence of the Mott Haven yard are divided in the same manner as those for the terminal. The provisions relating to the payment of premiums for insurance, taxes, assessments, maintenance, repairs and renewals and claims for damage, injury, etc., are likewise similar to those for the same charges at the terminal, division being made on the basis of "the proportion which the number of cars of the New Haven company entering Mott Haven yard bears to the entire number (excluding all crossing movements on the wye track near tower 'YD' and excluding all freight movements on the track designated as 'lead to yard B' and excluding all cars from the interior repair yard from the Central company shown on the map attached to schedule viii entering Mott Haven yard; it being understood that all cars in either company's service entering Mott Haven yard are for the purposes of this section to be regarded as such company's cars." Provision is similarly made for the New Haven to pay for the expense of hauling its cars to and from Mott Haven or other exterior storage yards, switching service, expense of cleaning, lighting, heating, stocking, repairing, watering and icing cars.

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[1] Section 16 provides that each company shall assume all liability for loss of or damage to property and for injury to or for the death of persons caused of its negligence or the negligence of its employees occurring in or upon said "Terminal or in Mott Haven Yard."

For the use of the electric distributing system between Port Morris power house and the contact shoes of its equipment using the same, the New Haven pays a proportion of 4¼ per cent. on the cost of construction, etc., the proportion being based on its proportionate use of the distributing system. There are the usual liability clauses.

As a basis and guide for making contracts relating to the joint use of terminal and other facilities the epitomized paragraphs given below may be of value. They give the important matter of a number of actual contracts between two large railroad companies.

Joint Operation of Freight Houses.—Preferably one company to employ the agent and his assistants, rendering bills to the other for its proportion of the wages; operating expense to be divided on the basis of pro-numbers,[1] forwarding orders and tonnage handled for the account of each company, each class to be figured out on a percentage basis and the average of the total percentages used to apply.

Joint Operation of a Passenger Station.—One company to employ the agent and his assistants rendering a bill to the other company for its proportion of the expense, based on the number of tickets sold for each company. The total charges to be divided on this basis will include also the expenses incidental to the handling of baggage and mail.

Joint Operation of Yards.—Payrolls to be handled by one company, which will bill proportionate expense to the other unless special conditions render other methods desirable. Division of expenses to be on basis of number of cars received in yard of each company.[2]

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[1] Pro-numbers are the "progressive" numbers of consignments of received freight, *i.e.*, the number of consignees' names. A waybill may contain one or a number of pro-numbers.

[2] In this and other paragraphs no reference is made to responsibility or liability. These are considered in separate paragraphs below.

Joint switching service may be established where one company can better perform such work than the other, as for example, because of its available motive power, because of interference which would result by reason of having two sets of crews attempt to work over the same switching centers or for other causes. In such cases special agreements should be made to fit each case on a basis satisfactory to the superintendents interested.

Joint engine-house operation may be considered under three general heads, as:

(*a*) *For engines turned*, on table or Y, and receiving no other attention: a fixed amount for each engine turned based on the average cost of turning at the particular point, charges to be billed against the other company by the road owning the facilities.

(*b*) *For engines turned and receiving other attention outside the house.*—The road other than the owning company to pay a proportion of 6 per cent. per annum on the cost of construction or present value of such tracks, turntables and buildings *as are used* (this excepting the round house and round-house facilities), a proportion of the cost of maintenance and of wages of the ash pit and turntable men and hostlers, these proportions to be based on the number of its engines turned as compared to the total number turned.

(*c*) *Engines entering the house;* the company owning the plant to bill the other company the actual cost of coal and water; actual cost plus 10 per cent.[1] for all supplies (except coal and water); actual time consumed by mechanics and others making repairs plus the value of the materials used, and in addition a part of the interest at 6 per cent.[2] on the value of the engine house, including land and engine-house facilities proper, a part of the charges for maintenance, etc., to be determined by the proportion which the number of engines of each company entering the house bears to the total.

Trackage Agreements.—Where the agreement is to continue for a long time and a considerable number of trains is to be handled the contract is usually made on a basis of 50 cents per train mile, the foreign road manning the trains, furnishing the motive power, coal, water and all supplies but operating under the supervision and regulation of the owning road. Under the regulations of the American Railway Association *detoured* trains are handled at $1.00 per mile, when the line for which the trains are detoured furnishes power supplies and all train help; at $2.00 per mile when the owning line furnishes engines, supplies and crews.

Responsibility and liability clauses are essential in joint agreements; and it is of the utmost importance that they be carefully recorded in order to avoid controversy or confusion. In a general way, there are two classes to be considered, the first being:

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[1] Or such other rate of interest as may be agreed upon.

[2] The interest varies according to conditions; in some instances 4 per cent. is used and in others a higher rate.

Personal injury cases, wherein each operating company is ordinarily responsible for accident or injury caused by its own employees provided such responsibility can be definitely traced to them. If the responsibility cannot be so fixed or if the employees of two or more companies are concerned, settlements are made and expense divided in the proportion of the operating and maintenance costs borne by each road.

Damage to or loss of property is ordinarily handled in a similar manner. In one instance an agreement exists between several roads operating a joint terminal to the effect that the company bringing baggage into the station for delivery to another company is responsible until the baggage has been placed in the baggage room. While the property is in the baggage room the joint interests are responsible. As soon as it is taken from the room the responsibility is transferred to the road over which the baggage is to be transported. There are two common methods of taking care of fines relating to the handling of United States mail at points of interchange or delivery. One is to divide the amount of the fine among the interested roads on the same basis as operating costs; the other is to have the road which handles the mail pay the fine, itself.

Damage to Detoured Trains.—The following is clause 4 (that defining liability) of the American Railway Association standard detour contract mentioned above.

> The Home Company shall not be held liable for or on account of any loss, damage or delay, to the trains, engines, cars or other property of any kind of either company, nor to freight, baggage or other property of any kind carried in or upon such trains, engines or cars, nor for or on account of any injury to or death of passengers or employees of either company, or other persons, whomsoever, which may be incurred or sustained by reason of such trains being detoured, or by reason of such trains being delayed in such detouring, in whatever manner the same may be caused or occasioned, whether by or through the negligence of the Home Company, its agents or servants, or by reason of defects in the tracks, structures or facilities furnished by the Home Company, or otherwise, it being understood and agreed that all risk of such delay, loss, damage, injury and death shall be and is hereby assumed by the Foreign Company, and the Foreign Company shall and will hold harmless the Home Company from and against all inability or claims for all such delay, loss, damage, injury and death, and shall and will execute and deliver, or cause to be executed and delivered, to the Home Company, upon request, a full and complete release, satisfaction and discharge of all claims therefor, and will pay, or cause to be paid, all costs and expenses incurred by either Company in the clearing of wrecks and repairs to equipment, track and property in which by reason of detour movements covered by this agreement the engines, trains or cars of the Foreign Company are concerned, expenses and attorneys' fees incurred in defending any action which may be brought against the Home Company on account of any such claim or liability and any judgment which may

be rendered against the Home Company on account thereof. The Foreign Company shall pay all fines, penalties, costs and expenses imposed upon or incurred by the Home Company by reason of any violation by the Foreign Company of the Safety Appliance or other State or Federal Laws, and hold the Home Company harmless therefrom.

CHAPTER IX

PASSENGER TERMINAL OPERATION

There is nothing connected with the activities of a railroad more conducive to adverse criticism or more detrimental to the comfort and convenience of the traveling public than inferior service on the part of the large passenger terminal. In nothing connected with the handling of passengers does the value of a thorough and efficient organization play a more important rôle, a fact which is particularly emphasized when emergencies are to be met as a result of derailments or other accidents, frozen switches, disabled interlocking machinery, etc. The organizations of large terminals vary greatly. It is the rule, however, to place the supreme command of the facility in the hands of one man who may be variously called the manager, station master, or terminal superintendent. In any case, this officer should be a man of such ability and experience that the management may feel free to repose full confidence in him and to allow him ample authority to act in any emergency. It is the lesson of experience that anything short of that will result in failure. The manager, of necessity, will usually have an assistant manager, station master or assistant station master, depending on the title of his superior. In some of the larger terminals a yard master may also be appointed to control the track movements between the terminal and the accessories such as the engine houses, coaling plants, and car-cleaning plants. The remainder of the force will consist of the yard conductors, switchmen, interlocking towermen, ticket agents, baggage handlers, truckers, porters, etc. There must also be such forces as are necessary to look after the construction and repair of buildings, the laying and renewal of track, and the operation and repair of mechanical and electrical equipment, including the lighting, heating and ventilating facilities, the elevators, and the ice and gas manufacturing plants.

The organization should aim primarily at efficiency and safety, and those employees who deal with the public should thoroughly understand that courtesy toward patrons is one of the first requisites of efficiency. It is true that many persons know no better than to be rude and offensive to employees of public service corporations. The employee, however, can and should be trained to let such treatment pass unnoticed. He should cultivate patience and control his temper. Questions asked may seem, and frequently are, foolish, but civil replies should always be given.

On the other hand, the employee should be impressed with the fact that he is not filling his position for the purpose of entertaining the public. He should answer questions carefully and courteously at all times, but it is not a part of that duty to enter into needless conversation with passengers.

Howard Elliott, chairman of the board and president of the New Haven covered this matter of proper courtesy recently under the head of "What a Railroad Ticket Covers" as follows:

> A railroad sells transportation, but it sells something else along with it. It sells "service." The price of a railroad ticket covers both.
>
> Transportation means the same thing on all railroads. Service may mean a very different thing on one railroad from what it does on another.
>
> Service means all the comforts which the equipment furnished provides. It also means the kind of treatment accorded the patron of the railroad while he makes use of this equipment. Respectful, courteous, and painstaking attention to his comfort on the part of agents, conductors, brakemen, and porters—this is one of the most important elements of good "service."
>
> A railroad that has a reputation for good service has an asset of incalculable value. It is service which brings patronage to the railroad. It is service which keeps business once it has been obtained by the railroad's solicitors. Any inattention towards the railroad patron by the railroad employee, any discourtesy, any display of bad temper or an unwillingness to please or to be accommodating, is a partial breakdown of railroad "service."
>
> Railroad service begins at the ticket office when the railroad patron buys his ticket. It ends at the station where he alights. Between these two points should stretch the railroad smile. It helps business.
>
> First impressions count for much in life. That is why a smile at the ticket office window and a display of affability, courtesy, and willingness to answer questions and give information on the part of the agent is essential to good railroad "service." It creates in the mind of the railroad patron a pleasant picture of the railroad.
>
> And this picture is likely to be retained and embellished if later the patron of the railroad is helped on the train by the brakeman or conductor, if he finds his comfort looked out for, his inquiries answered pleasantly, his ticket asked for with a smile, and assistance offered when he alights. All this means service.
>
> Good service depends not only upon what you do, but upon the way you do it. That is true whether you be a clerk in a drug store or a brakeman on a railroad.
>
> Smiles are remembered just as well as frowns. The one helps to make service good; the other helps to make it bad.
>
> A smile is like putting money out at interest. A frown is worse than a bad debt.
>
> The public prefers the railroad whose service, from the ticket window to the terminus of the journey, is made up of smiles, kind words, and thoughtful acts.

Some very apt instructions relating to terminal operation are included in the rules governing the operating department of the Terminal

Railroad Association of St. Louis, some of which are quoted below. There are handled each day into and out of the Union Station 280 to 300 passenger trains, not including light engine movements, nor movements of deadhead equipment from storage yards.

Baggage mail, express or other trucks must not be left where they are liable to be pushed or blown on the tracks or to be run against by passengers; they must not be wheeled along side a car from which passengers are alighting; at no time occupying more than one-half the width of platforms, and at all times, when not in use they must be kept in the place assigned for them. No freight or other matter must be unloaded from trains arriving with mail, express or baggage cars next to bumping post until all pasengers have passed out.

Water, gas and other hose must never be left where passengers will trip over them.

Porters handling trucks must exercise great care and look for moving trains before crossing tracks and avoid standing on switches.

Porters must not sweep a platform at which a train is receiving or discharging passengers, or cause any dust to arise near trains occupied by passengers. The cleaning of cars in shed is prohibited between the hours of 6.30 A.M. and 9 A.M., and between 4 P.M. and 9 P.M., except only such cars as are doubled out on short notice.

Paper and other refuse must be put in the boxes provided for that purpose, and must not be thrown on the tracks or platforms.

Care must be taken to keep in and about buildings clean and free from rubbish, sweepings, hot ashes and all inflammable material.

The safety of passengers is the first consideration; to this, together with the safety, regularity and punctuality of trains and the comfort and convenience of passengers, all operations must be completely and entirely subordinate.

Employees or other persons must not board trains arriving at the station until passengers have left them and the cars have been searched for lost articles.

No person will be allowed in the baggage, parcel or lost article rooms except persons employed there.

Every employee must remain in the place assigned to him, and the reading of newspapers, books, etc., while on duty, will not be permitted.

Employees, when on duty or in uniform, will not be allowed to occupy seats in the waiting rooms or loiter about the waiting rooms, bumping posts or train platforms, except when in discharge of their duties.

Gatemen must not allow passengers to take large or objectionable bundles through the gates, to the inconvenience of other passengers. Bicycles, baby carriages and such other bundles must be handled through baggage room.

Gatemen must not leave their gates at any time without the permission of the station master. They will not allow any persons to stand or loiter about the gates while admitting passengers to trains, and must devote their time to seeing that passengers have tickets and are directed to the right train, and must be ready to give proper and desired information at all times.

No tail hose, lamps or other train equipment must be placed on the station platform or stored around the bumping posts.

No trucking of or dragging of material will be allowed on granitoid between bumping posts and midway fence.

No employee of this company will be permitted to escort passengers to hotels or other places outside of the station.

Gatemen will not permit passengers to enter gate to take train after it has started.

No packages, hand baggage, etc., will be allowed on the waiting room seats.

Dogs must not be allowed to remain in first-class waiting rooms; they should be placed in check room or taken to second-class waiting room.

The soliciting of business by passenger agents on station property is not permitted.

All property found in waiting rooms or on station platform unattended must be deposited with the baggage room storekeeper, who will issue a receipt for each such article.

Bicycles must not be ridden on the station property.

There is much difference of opinion in this country regarding the showing of tickets at platform gates. The matter is largely one of local likes and dislikes and the same railroad will often adopt quite unlike methods in different communities. The idea of presenting tickets has a number of advantages, but it is a question whether the inconvenience caused the patron does not outweigh them. The most important element in its favor is the guarantee that is given before it is too late that the passenger will not board the wrong train and be carried many miles out of his way. The showing of tickets also serves to keep the platforms free of outsiders. The latter may otherwise needlessly crowd the platforms with resulting inconvenience to all concerned, or they may get into out-of-way places where they do not belong and run the risk of being run down by locomotives, cars or trucks. In electrically operated terminals there is danger of coming in contact with live wires or rails.

Nevertheless, many stations are operated efficiently in which patrons do not show their tickets. Something depends upon the train indicators. If they are sufficiently complete and give in detail the name of the railroad, the time of departure, the name of the train, if it has such, and the stations at which it stops there is but little reason why passengers should be confused, and that, particularly, if the information bureau is efficient and the gatemen are "on the job." In many stations, moreover, are posted great bulletins giving in chronological order the names and destinations of all trains leaving the terminal during the day, the time of departure and the track from which each train will leave. These lists are of great convenience to patrons and greatly relieve the information bureau and gatemen. Sometimes, too, placards are hung from the sides of the cars naming the destinations for which the cars are intended. This, likewise, is of service to all concerned and is of special use in the case of trains which have cars for various branches to be cut off at junction points on the run.

There is no denying that the average passenger finds it an inconvenience to show his ticket at the gate. If he is burdened with suitcases he is especially bothered either because he must enlist the services of a red-cap porter—and pay him his price—or because he must put down his burden and make a search for the ticket. The commuter, to be sure, can be educated but he would appreciate it if he were not delayed in the rush hours by being in a crowd which must narrow down to single or double file to get through the gates. The terminal officers, likewise, are inconvenienced, first because the terminal force must be enough larger than otherwise to include the extra men necessary to inspect the tickets. It is one of the necessities of busy terminal operation that suburban trains be backed in, loaded and pulled out in the shortest possible time. The extra minute or two which the crowd takes to get through the gates in double file is no small matter under such conditions.

One cannot refute the argument that the showing of tickets does keep the platforms free of persons who do not belong on them and that in some terminals, where there are long tunnels, electrically operated trains, or the like, it is absolutely necessary that the trespasser be kept out. That passengers boarding trains in such terminals should show their tickets is not only advisable but essential; it does not seem advisable in other terminals where there are not similar conditions.

The experience of some of the railway administrations of Europe in this respect is worth consideration. Professor W. J. Cunningham of Harvard University said in a paper entitled "The Administration of the State Railways of Prussia-Hesse," read before the New York Railroad Club on April 18, 1913:

> "Before leaving the passenger service, mention should be made of the practice of selling 'bahnsteig' (platform) tickets which permit the friends of incoming and outgoing passengers to meet or part with them on the station platform at the car door. These tickets, which cost 10 pfennig (2.4 cts.) are procured through slot machines. They are punched by the gateman when the holders pass through the gate to the platform and are collected when they leave the platform. In 1910, 31,000,000 of such tickets were sold (85,000 per day) and they yielded a revenue of $735,000. This, of course, is clear profit."

It is a safe presumption that there is a demand for such tickets in this country.

Turnstiles are a nuisance. They are rarely absolutely necessary, and are a serious handicap to travelers with suit cases or bundles. In most cases if employees were stationed to watch the exits instead the improved good will of the patrons would pay his wages almost a hundred fold.

The "red-cap" porter, or the "red-cap" as he is more usually called, has become an institution which the American traveling public could ill afford to be without. The red-cap under proper supervision is remarkably efficient and useful and the railroads are to be complimented for the fine class of men they have assembled to do this work. The station master must always be careful, however, that the porters in his station do not seek out the well-groomed gentlemen and ladies, from whom a fat tip is reasonably sure, to the neglect of the poor and weak who very likely are much more in need of their services but do not appear willing to pay therefor. On the other hand, he must also take care that his red-caps are not too insistent and that they do not make themselves more of a nuisance than anything else.

Cars for outgoing trains are placed on station tracks in various ways. In most cases, they are pulled or backed in by switch engines, the road engine being coupled on later. This is almost always the case with through trains in particular because the coaches and Pullman cars are brought from the coach yard and the baggage and mail cars from the special baggage and mail tracks. At many terminals, and particularly in head stations where there is a large suburban service, spot trains are used, the spot train being an incoming train to the rear end of which is attached the engine which will take the train on its outward movement, the engine at the former forward end being uncoupled and following the train as it goes out of the terminal. Some stations are so handicapped for time and facilities that many cars have to be "kicked"[1] or "dropped"[2] onto their respective tracks. At many stations, also, it is found necessary to back in or pull out trains completely made up, a mode of operation, incidentally, which, where it can be used, as with local trains and with some through trains, is very economical, saving as it does light engine movements, congestion on the interlocking and time. The train is backed in ready to receive its passengers, with the air already tested, the cars inspected and everything ready for an immediate outward movement.

To move a train backward over a station's approaches and interlocking with safety and speed requires the assignment of reliable, experienced and competent employees for the work. The simplest way to make a movement of this kind is to let the engineman on the rear of the train be governed by air or hand signals given by a trainman on the head (rear) end, the trainman, of course, having been examined and qualified on the road and signal characteristics. A safer plan is to attach the "back-up-hose" to the end of the main air line of the air-brake equipment on the rear end of the train. This hose has a valve by which the trainman can apply the brakes and usually has a second valve whereby he can sound an air whistle to warn persons on or near the track. On many roads every passenger train car is provided with a "goose-neck" pipe connection for this purpose, which being a part of the car's permanent equipment is always available. This goose-neck is operated by a fixed valve or by a key carried by the trainman. With it as with the "back-up-hose," the engineman is governed by the air brake handling from the end of the train and works his engine accordingly.

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[1] "Kicking" cars refers to a movement whereby a quick start is given by the engine which is then detached, the cars being permitted to continue by their momentum until stopped of themselves.

[2] "Dropping" is letting a car run by gravity or by being detached without special power being applied. Either kicking or dropping cars is exceedingly dangerous and should be done only as a last resort.

Passenger cars should not be kicked or dropped onto a track occupied by cars containing passengers. Preferably when coupling passenger cars, a stop should first be made from 10 to 30 ft. from the standing cars. In like manner occupied passenger cars should not be detached while the cars are in motion. "Flying switches"[1] should be avoided unless they are absolutely necessary. If they must be made, the train should be stopped and careful tests made to show that the switches and brakes are in good working order. "Running switches"[2] likewise are objectionable and should be avoided.

To state that an adequate telephone system is absolutely necessary in any large passenger terminal is to state a self-evident fact that need not be enlarged upon. There are very few large stations in this country that lack a private exchange and it is difficult to see how a terminal of any size could be operated efficiently without an exchange or its equivalent.

Automatic intercommunicating telephones are frequently advocated. The Michigan Central terminals at Detroit, are served by a complete set of them. The board handles all local calls in the passenger terminal building, in the yards and terminals extending to the old station and the freight house, and several telephones are installed in the Windsor, Ont., yard, 3 or 4 miles from the station. Because of the length of the lines and the number of yard telephones originally on party lines, a six-party code ringing reverting call system was used. There are 125 lines with a total of 225 telephones, the party line system having been retained to avoid excessive line construction through the yards. The method of operation is to remove the receiver from the hook, move the dial on the telephone to the desired number and to push the ringing button

[1] "Flying switches" are movements in which the engine pulls a car (or cars) sufficiently to get it under way and then is uncoupled, a switch being thrown after the passage of the engine, thus shunting the car onto an adjacent track. The movement is one to be avoided unless absolutely necessary.

[2] A "running switch" consists of dropping out one or more cars while the train is in motion. In the olden days when "Safety First" would have been a term of derision rather than of commendation the trainmen liked to tell about cutting cars out of the middle of a freight train, dropping them in on a facing point side track and recoupling the remainder of the train without stopping. A favorite western railroad story tells of a stock train which changed engines and cabooses while running through a division terminal without reducing speed below 20 miles an hour.

the necessary number of times. If the board were a single-party line board or an harmonic ringing board the last would be unnecessary. The saving of this system over the regular exchange sytem was estimated at about $3,500 yearly, $1,000 being savings in rentals and the remainder operators' wages. Each call, in addition, is thought to save about 18 seconds. The board itself is in the telegraph office. It is equipped with alarm fuses and an automatic alarm. But little inspection is needed, it being found that it suffices to see that the battery is in shape, the lines intact and the board kept clean.

There are several methods of starting passenger trains from terminals. Usually the gateman simply closes the gate at or just before the actual schedule leaving time and signals the conductor who in turn transmits the signal by hand to the engineman. At some places the gateman when closing the gates, signals the towerman at the head of the yard by some means of electrical communication. An ingenious means of meeting a difficult situation was once used at the Jersey City Terminal of the Pennsylvania Railroad where one, two, three and sometimes four ferry boats had to connect with one or more outgoing passenger trains. A porter from each boat followed the passengers and delivered an authorization or clearance slip to the train conductor who also received a signal from the gateman when the gates were closed. The conductor when he had received his signal and his clearance slips then signaled tower "A"—controlling the starting movement—by pressing a button under the edge of the platform, the exact location of this button being designated by a brass strip on the surface of the platform. If the route was properly set up and clear, the towerman then dropped the starting signal.

A rather complicated system is in use in the North Western Terminal in Chicago. Each of the station's 16 tracks is sufficient for two trains. Along each platform there are four conductor's boxes (two for each train) Each box has a push button and two lights and connected with every second box there is a telephone. The director's table in the interlocking tower has three lights and a push button for each of the two possible trains on each track. At the gate there are also two push buttons, one for a train at the outer end of the platform and one for a train at the inner end, each button being used in connection with two lights. The conductor of a through train pushes his button one minute before train time. This lights the top light on the director's table and the first light at the gate reminding the director and the gateman that it is nearly time for the train's departure. The director, at once if possible, pushes his button for that end of the track, this putting out the top light and lighting the second one on his table, lighting the top conductor's light and putting out the first and lighting the second light at the gate. The gateman as soon as he has closed the gate and allowed the last passenger time to board the train, pushes the proper button. This lights the lower of the conductor's lights and the third director's light and the conductor signals his engineman to proceed. The system is automatically restored to normal again when the first interlocking signal is again made to indicate stop. In the case of suburban trains which move on a closer margin of time, the conductor merely pushes his button 10 seconds before train time, but does not wait for an answer. When a train is ready to back out after unloading its passengers, the conductor or back-up man pushes the conductor's button. The tower director, as soon as he can, then pushes his button, lighting the top conductor's light whereupon the movement may proceed.

The telautograph is another intercommunicating device which is coming into universal service in railway passenger terminals. In the North Western terminal there are three transmitters, one in each division despatcher's office and one in the Lake Street interlocking tower. Information is sent to 19 receiving instruments, on the concourses, in the terminal superintendent's office, in the information bureaus, etc., relative to time and track numbers of arriving trains, delays and other such matters.

Although car cleaning is usually done in the car-cleaning yards (described in Chap. XIV) it is occasionally necessary to do some light cleaning in the station of cars or trains being "doubled" out. This may be done by brushing and light sprinkling, by the use of vacuum cleaners or by using compressed air to blow the dirt out of the seats after which it is brushed off with whisk brooms. The vacuum cleaner is the best adapted for this work although it has been claimed that it is likely to injure good plush.

Train inspection to detect failures that may cause accident is ordinarily taken care of at the storage or make-up yards but nevertheless something of this kind must also be done at the terminal and at important intermediate stations. In these inspections, the wheels are examined to see that there are no broken or chipped flanges or treads. The journal boxes are felt for any indications of heating, and it is necessary to look over the brakes and rigging, the truck frames and other parts of the "running gear." Air-brake inspection to determine whether the piston-travel is within correct limits and whether the brakes apply and release properly and tests of the air communicating signal are made before the train starts and at every point en route where for any reason a coupling is made or parted.

The snow problem is one of the biggest of all the problems a passenger terminal has to meet. It is not easy to keep the interlocking in working order in a heavy storm, but there are, nevertheless, altogether too many terminal organizations in this country that occasionally collapse almost as soon as the ground is white with snow. When the terminal cannot do its work, the line cannot. It is essential that the switches and platforms be cleaned promptly, not only for the safety of passengers but to avoid detentions and prevent accidents. This work of getting rid of the snow should be begun before the storm has obtained too great a start. It is the best for all concerned that those who will have to do the work at a particular point be designated beforehand, for that will avoid controversy or failure.

In cleaning snow and ice from switches, frogs and tracks, saving of time and money can be made by the hydro-carbon method now generally employed, or by the use of compressed air obtained either from a stationary compressor plant or from a locomotive equipped with two or more air pumps and several lines of hose.[1]

The Pennsylvania Railroad in getting rid of snow on its Philadelphia Terminal Division sometimes melts the snow at switches with burning oil. It has also adopted a scheme of blowing the snow out of the way by means of hot steam delivered through a pipe between the wheels of a locomotive. Melting pits have also been found of value, but one of the most notable devices is a gondola car specially fitted for melting snow with steam pipes and tanks. The car has an inside compartment 38 ft. 2 in. long, 9 ft. 3 in. wide and 3 ft. 9 in. deep. About one foot below the top there is a false bottom, and in the pan thus formed there are steam pipes of various lengths open at the ends. As the snow is thrown in the car it is immediately melted and soon becomes boiling hot water which makes short work of the snow which follows. At the center of the pan there is a small manhole 11 in. high through which the water overflows to the lower part of the car, 2 ft. 6 in. deep, which serves as storage space. With snow of average compactness, about 25 ordinary carloads of snow can be thrown in the car before its tanks are full. Twenty men in a working day of 10 hours can fill the car to capacity only three times.

Proper police protection in passenger terminals, on passenger trains or elsewhere is a good advertisement for any road for the reason that it reassures the public and guarantees the passengers from molestation. Most railway companies have an organization usually headed by a chief special officer who in turn has a division special agent on each division working in conjunction with the division forces. On special days or days of heavy travel the force is usually augmented and concentrated at the point or points of greatest congestion. Recovering and restoring lost or stolen articles, preventing petty thieving and—by no means least—checking the activities of professional card-playing sharps on trains, are among the varied duties of these special officers. It is remarkable that so many respectable and ordinarily intelligent persons will permit themselves to be drawn into card games with strangers.

[1] Both of these methods are described on page 57 of Freight Terminals and Trains.

On one road, the conductors make it a point to say to persons starting a game: "Gentlemen, if you know each other, well and good; if not, I want to caution you, because we are having many complaints regarding the results of card games." Usually this is received in the proper spirit. When it is not, there are probably reasons for vigilance. The special officers do considerable work in preventing thefts of parcels or trunks—or in assisting in their recovery after they have been stolen. It is part of their duty also to assist the regular station attendants in keeping order, in keeping the crowds moving in the right direction, and in arranging the lines of patrons at the ticket windows, the parcel counters, the baggage room counters and the information bureau.

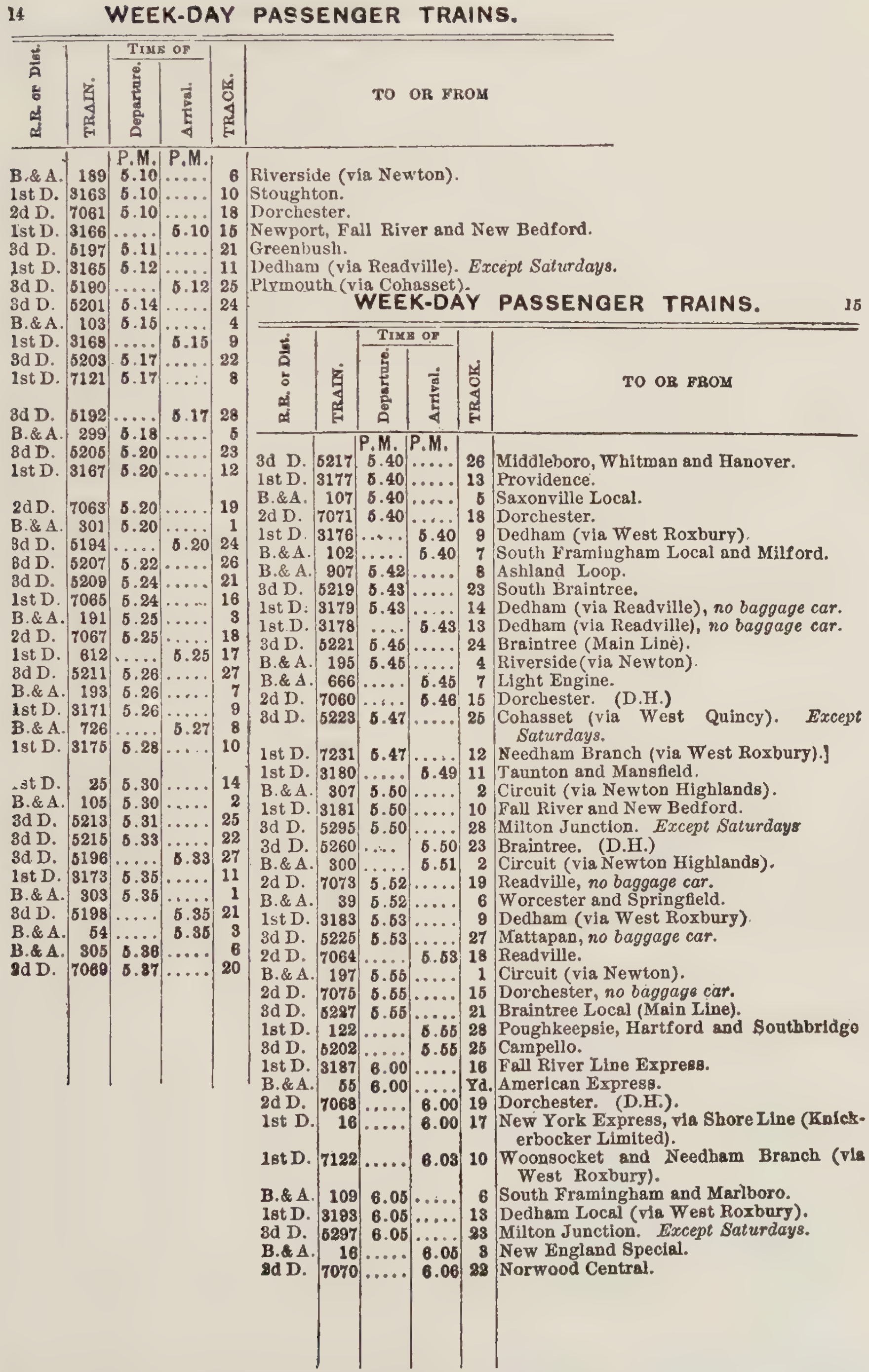
The announcing of trains, both inbound and outbound, is made or attempted in various ways. The passenger department's ubiquitous folder is the starting or pivotal point and is the main stay of the passenger. After the time-table there come the train indicators. Those for departing trains are described in detail in Chapter XII. The bulletin board for arriving trains, so time-honored as hardly to need description, is usually simply a blackboard ruled with vertical and horizontal lines and upon it are noted the number and the point of origin or name of the incoming train, the time it is due, the number of minutes late (if it is not on time) and the track on which it will arrive. In most stations there is usually a caller or station attendant, armed with a megaphone if necessary, who announces the arriving and departing trains. The necessary information regarding incoming trains is received in the office of the station master who has a telegraph or telephone connection with the train despatcher. In large stations where there are so many trains that misunderstandings are likely to occur and cause inconvenience, the message is received in writing on the telautograph. A device has been tried at a number of large terminals whereby the announcer speaking into one transmitter makes himself heard in several rooms simultaneously by means of telephonic connection with amplifying devices and megaphones. The idea has its limitations, however, and has had to be abandoned in several cases because the acoustic properties of the vast halls were such that the message was drowned in its own echoes.

The immigrant agent is an officer found primarily in the large terminals on the Atlantic seaboard. It is his duty partly to induce immigrants to travel over his line but primarily to see that they are properly cared for while getting started on their railroad journeys. The agent must be able to speak a number of languages or at least be in a position to call on other station attendants who can. He must also be familiar with routes, rates, trains and kindred matters. In most terminals he and his helpers wear caps with designating badges and in some cases the agent's photograph appears in the passenger department folders.

The time required to load and unload passengers, baggage and express at stations varies within wide limits. It depends mainly on the character and volume of the business handled by the different trains and the facilities provided to insure rapid movement. The passengers on long distance trains can ordinarily be loaded much more quickly than the baggage and express. On account of the comparatively small amount of baggage and express handled on short distance or suburban trains, the condition may be reversed. To obtain the fullest use of track capacity, express, theatrical goods and heavy baggage should be loaded before the train is made up and placed at the platform.

The design of car has much to do with the speed at which passengers board and leave trains at terminals. The system adopted by the Illinois Central for its suburban lines out of Chicago is good in this respect, the cars used being of sufficient width—over 10 ft.—to permit of cross seats with doors all along the side and an aisle next to the doors. In the Hudson tunnels operated by the Hudson & Manhattan in New York, the cars are limited to something over 8 ft. in width, and on them as on the elevated lines of Boston and Philadelphia and the Interborough subway of New York both side and end doors are used. In several of the Hudson & Manhattan stations, as also in many other places of similar character, separate platforms are arranged for outgoing and incoming passengers. Incoming patrons leave a train through the doors on one side and outgoing patrons board it through the doors on the opposite side, the movement taking place very expeditiously. The car doors, as those on the cars of the Boston and Philadelphia elevateds or the New York, Westchester & Boston are operated by pneumatic pressure controlled from the end of the car by pneumatic or electric levers or switches. They slide on ball-bearings and are edged with rubber hosing to prevent harm to passengers' fingers inadvertently stuck between the door and its frame. In the New York subways the doors are similar with the exception that the end doors are operated mechanically and that on the edge of each door there is a spring arrangement instead of rubber hosing. As on the Boston elevated an electrical signal circuit with contacts at each door runs the entire length of the train, it being so arranged that the motorman has an indication in the form of a miniature light or a buzzer, that all the doors in the train behind him are shut. Without such an arrangement, indeed, it would be physically impossible to operate the express service between Brooklyn Bridge and 96th Street at its present efficiency.

In large and particularly expensively operated passenger terminals the ideal is reached when all cars arriving and leaving the station are loaded to maximum capacity and there is no inconvenience to passengers thereby. In other words, the freight car and freight train principle applies with the exception that there are many, many protestants at hand if the economical factor is carried too far. The New York, New Haven & Hartford and the New York Central are compelled to watch this



14 **WEEK-DAY PASSENGER TRAINS.**

R.R. or Dist.	TRAIN.	TIME OF		TRACK.	TO OR FROM
		Departure.	Arrival.		
		P.M.	P.M.		
B.&A.	189	5.10	.....	6	Riverside (via Newton).
1st D.	3163	5.10	.....	10	Stoughton.
2d D.	7061	5.10	.....	18	Dorchester.
1st D.	3166	.....	5.10	15	Newport, Fall River and New Bedford.
3d D.	5197	5.11	.....	21	Greenbush.
1st D.	3165	5.12	.....	11	Dedham (via Readville). *Except Saturdays.*
3d D.	5190	.....	5.12	25	Plymouth (via Cohasset).
3d D.	5201	5.14	.....	24	
B.&A.	103	5.15	.....	4	
1st D.	3168	.....	5.15	9	
3d D.	5203	5.17	.....	22	
1st D.	7121	5.17	.....	8	
3d D.	5192	.....	5.17	28	
B.&A.	299	5.18	.....	5	
3d D.	5205	5.20	.....	23	
1st D.	3167	5.20	.....	12	
2d D.	7063	5.20	.....	19	
B.&A.	301	5.20	.....	1	
3d D.	5194	.....	5.20	24	
3d D.	5207	5.22	.....	26	
3d D.	5209	5.24	.....	21	
1st D.	7065	5.24	.....	16	
B.&A.	191	5.25	.....	3	
2d D.	7067	5.25	.....	18	
1st D.	612	.....	5.25	17	
3d D.	5211	5.26	.....	27	
B.&A.	193	5.26	.....	7	
1st D.	3171	5.26	.....	9	
B.&A.	726	.....	5.27	8	
1st D.	3175	5.28	.....	10	
1st D.	25	5.30	.....	14	
B.&A.	105	5.30	.....	2	
3d D.	5213	5.31	.....	25	
3d D.	5215	5.33	.....	22	
3d D.	5196	.....	5.33	27	
1st D.	3173	5.35	.....	11	
B.&A.	303	5.35	.....	1	
3d D.	5198	.....	5.35	21	
B.&A.	54	.....	5.35	3	
B.&A.	305	5.36	.....	6	
2d D.	7069	5.37	.....	20	

WEEK-DAY PASSENGER TRAINS. 15

R.R. or Dist.	TRAIN.	TIME OF		TRACK.	TO OR FROM
		Departure.	Arrival.		
		P.M.	P.M.		
3d D.	5217	5.40	.....	26	Middleboro, Whitman and Hanover.
1st D.	3177	5.40	.....	13	Providence.
B.&A.	107	5.40	.....	5	Saxonville Local.
2d D.	7071	5.40	.....	18	Dorchester.
1st D.	3176	.....	5.40	9	Dedham (via West Roxbury).
B.&A.	102	.....	5.40	7	South Framingham Local and Milford.
B.&A.	907	5.42	.....	8	Ashland Loop.
3d D.	5219	5.43	.....	23	South Braintree.
1st D.	3179	5.43	.....	14	Dedham (via Readville), *no baggage car.*
1st D.	3178	.....	5.43	13	Dedham (via Readville), *no baggage car.*
3d D.	5221	5.46	.....	24	Braintree (Main Line).
B.&A.	195	5.45	.....	4	Riverside (via Newton).
B.&A.	666	.....	5.45	7	Light Engine.
2d D.	7060	.....	5.46	15	Dorchester. (D.H.)
3d D.	5223	5.47	.....	25	Cohasset (via West Quincy). *Except Saturdays.*
1st D.	7231	5.47	.....	12	Needham Branch (via West Roxbury).]
1st D.	3180	.....	5.49	11	Taunton and Mansfield.
B.&A.	307	5.50	.....	2	Circuit (via Newton Highlands).
1st D.	3181	5.50	.....	10	Fall River and New Bedford.
3d D.	5295	5.50	.....	28	Milton Junction. *Except Saturdays*
3d D.	5260	.....	5.50	23	Braintree. (D.H.)
B.&A.	300	.....	5.51	2	Circuit (via Newton Highlands).
2d D.	7073	5.52	.....	19	Readville, *no baggage car.*
B.&A.	39	5.52	.....	6	Worcester and Springfield.
1st D.	3183	5.53	.....	9	Dedham (via West Roxbury).
3d D.	5225	5.53	.....	27	Mattapan, *no baggage car.*
2d D.	7064	.....	5.53	18	Readville.
B.&A.	197	5.55	.....	1	Circuit (via Newton).
2d D.	7075	5.55	.....	15	Dorchester, *no baggage car.*
3d D.	5227	5.55	.....	21	Braintree Local (Main Line).
1st D.	122	.....	5.55	28	Poughkeepsie, Hartford and Southbridge
3d D.	5202	.....	5.55	25	Campello.
1st D.	3187	6.00	.....	16	Fall River Line Express.
B.&A.	55	6.00	.....	Yd.	American Express.
2d D.	7068	.....	6.00	19	Dorchester. (D.H.).
1st D.	16	.....	6.00	17	New York Express, via Shore Line (Knickerbocker Limited).
1st D.	7122	.....	6.03	10	Woonsocket and Needham Branch (via West Roxbury).
B.&A.	109	6.05	.....	6	South Framingham and Marlboro.
1st D.	3193	6.05	.....	13	Dedham Local (via West Roxbury).
3d D.	5297	6.05	.....	23	Milton Junction. *Except Saturdays.*
B.&A.	16	.....	6.05	3	New England Special.
2d D.	7070	.....	6.06	22	Norwood Central.

FIG. 129.—Arrival and departure book showing rush hour at South Station, Boston.

loading of the trains entering and leaving the Grand Central Terminal more closely than most roads without similar conditions.[1] At all large terminals, however, careful counts are made and records kept of cars, seats and seat-occupation in arriving and departing trains. This data must be prepared if for nothing more than to meet complaints from persons—reasonable and unreasonable—as to lack of seats.

The business handled in a large terminal is the yard stick by which are measured the service to be given and the cost thereof. It will be interesting, if nothing more, to examine the records of some of this country's more important stations.

The Boston South station is the busiest in the United States. A recent time-table for that terminal shows 817 regular trains (90 of which leave and arrive in one hour), in and out, each week day, besides 385 drafts to and from storage yards and 365 light engine movements—making a grand total of 1,567 movements. The same time-table shows a Sunday service of 288 regular trains, 125 drafts and 195 light engines, a total of 608 movements. Two-thirds of the regular trains are suburban without baggage or express matter in quantity—thereby reducing interference on the crossovers and interlocking.

The 1914 summer time-table of the electrically operated Grand Central Terminal in New York contained the following recapitulation:

GRAND CENTRAL TERMINAL
Recapitulation

	Upper level	Lower level	Total
Week Day Trains.			
Passenger trains Hudson-Electric	60	65	125
Passenger trains Harlem-Electric	44	72	116
Passenger trains N. Y., N. H. & H. R. R.	93	50	143
Grand total passenger trains	197	187	384

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[1] A careful record is kept at Grand Central Terminal, New York, by the New Haven, of every one of the some 130 trains in and out daily, as well as of the trains in and out of the Harlem River Terminal, Willis Avenue. These records, besides containing a detailed statement of the engines or electric locomotives and number and kind of cars, personnel of crew, tons, show the seat capacity, and utilization of such capacity separately for ordinary cars, chair cars and sleepers, and these figures are worked out to show the interesting recapitulation of percentage of seating capacity utilized on each train each month. For instance, in November, 1914, the percentage varied from 26—on branch line night through trains—to 95 on local trains during heavy commuter hours. A general average of 60 per cent. boarding may be considered good. The Pullman is, and should be, about 20 per cent. higher. For a more detailed discussion of such statistics see Chap. XXII on Statistics of Passenger Service.

GRAND CENTRAL TERMINAL.—(*Continued*)

Recapitulation

	Upper level	Lower level	Total
Mott Haven yard storage	106	6	109
Average number of light engines	40	......	40
Average number of construction trains	6	6	12
Transfers via 57th Street	40	30	70
Grand total movements to and from terminal	386	229	615
Sunday Trains.			
Passenger trains Hudson-Electric	54	39	93
Passenger trains Harlem-Electric	25	36	61
Passenger trains N. Y., N. H. & H. R. R.	56	25	81
Grand total passenger trains	135	100	235
Mott Haven yard storage	73	1	74
Average number of light engines	28	1	29
Average number of construction trains	......	......	......
Transfers via 57th Street	30	20	50
Grand total movements to and from terminal	266	122	388

All of these movements are made on four tracks.

In the fiscal year ended June 30, 1913 these two stations handled the following traffic, the figures being shown by months:

	South Station		Grand Central
	N. Y., N. H. & H.	B. & A.	
July, 1912	2,284,509	780,281	1,799,846
August	2,315,690	892,066	1,837,554
September	2,280,484	815,284	1,871,229
October	2,590,245	917,630	1,936,891
November	2,426,490	847,229	1,820,461
December	2,424,052	851,708	1,865,416
January, 1913	2,401,067	841,949	1,861,352
February	2,130,615	754,470	1,618,526
March	2,425,051	853,869	1,902,549
April	2,397,717	850,869	1,896,327
May	2,451,496	866,208	2,023,402
June	2,219,983	793,160	1,971,742
Total	28,347,399	10,064,108	22,405,295

The total number of passengers in and out of South Station was 38,411,507;[1] total in and out of the Grand Central 22,405,295; a daily average for South Station of 105,237 and for the Grand Central 61,397. During the year the number of people who departed from the Grand Central was 226,391 more than arrived there; and there was an increase in the total number using the station of 842,674 over the previous year. Although the average number of passengers on trains arriving and departing on trains at the Grand Central Terminal was not quite 62,000 it is to be noted that the terminal will ultimately have a capacity of 70,000 persons an hour.

The busiest day in the history of the South Station was June 8, 1912, at the time of the street car strike in Boston when the station handled 190 extra trains in addition to 811 regular scheduled trains, a total of 1,001, with 208,380 passengers. It has been estimated from counts taken on typical days that including those arriving and departing on trains over 60,000,000 people pass in and out of this station yearly.

The North Station in Boston stands next to its sister station, the South Terminal, in point of business handled, there having arrived and departed on its trains in the fiscal year June 30, 1913, 29,510,875 persons, thus making North Station the busiest terminal in the country used by trains of but one railroad.

Some other records of interest are the following:

The Pennsylvania Terminal in New York City now handles on its winter schedule 334 trains daily in and out, 210 of the total being Long Island trains. The number in summer is, of course, much greater. The Long Island in 1913 brought to and from the station 9,619,071 passengers, comparing with 7,753,958 in 1912, and 6,224,429 in 1911, there having thus been an increase of about 50 per cent. in but two years. The Pennsylvania station is not the Long Island's busiest terminal, it having handled at its Flatbush Avenue station in Brooklyn where connection is made with the Interborough subway, 17,501,524 patrons in 1914; 15,772,402 in 1913 and 14,094,003 in 1912.

At the Pennsylvania's Broad Street Terminal in Philadelphia there arrived and departed during 1913, 22,344,004 passengers, an average of 61,216 daily.

The Delaware, Lackawanna & Western station at Hoboken in the fiscal year ended June 30, 1913, took care of 17,000,000 passengers on its trains and in addition 18,800,000 ferry patrons who use only the ferries between Manhattan and Hoboken.

In the 12 months ending March 31, 1914, the passenger traffic through the Hudson Terminal of the Hudson & Manhattan was 30,535,500, there being an average of 858 trains operating on week days and 670 trains on

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[1] The South Station in the calendar year 1915 (an abnormally poor year) handled 34,259,691 passengers.

Sundays, making 5,818 trains a week, with an average of 101 passengers a train.

During 1913, 40,426,014 passengers were carried between San Francisco and Oakland, Alameda, Richmond and Sausalito. During 1912 the

DAILY PASSENGER TRAIN MOVEMENT

Chicago Passenger Stations

Stations and roads	Through			Suburban			Grand total
	In	Out	Total	In	Out	Total	
Union—							
C. B. & Q.	15	16	31	33	30	63	94
P. C. C. & St. L.	10	10	20	......	......	......	20
P. Ft. W. & C.	18	20	38	10	6	16	54
C. & A.	10	10	20	......	......	......	20
C. M. & St. P.	27	31	58	17	16	33	91
Total	80	87	167	60	52	112	279
Grand Central—							
B. & O.	7	7	14	2	2	4	18
C. G. W.	4	4	8	......	......	......	8
P. M.	6	6	12	......	......	......	12
Total	17	17	34	2	2	4	38
Total C. & N. W.	60	61	121	96	93	189	310
La Salle—							
L. S. & M. S.	17	20	37	18	18	36	73
C. R. I. & P.	16	15	31	38	37	75	106
C. I. & S.	3	3	6	......	......	......	6
N. Y. C. & St. L.	3	3	6	......	......	......	6
Total	39	41	80	56	55	111	191
Dearborn—							
A. T. & S. F.	7	8	15	......	......	......	15
C. & W. Ind.	......	......	......	11	11	22	22
G. T.	7	6	13	4	4	8	21
C. & O.	3	3	6	......	......	......	6
C. & E. I.	12	11	23	2	3	5	28
Monon	8	8	16	......	......	......	16
Erie	7	5	12	......	......	......	12
Wabash	10	9	19	3	4	7	26
Total	54	50	104	20	22	42	146
Illinois Central—							
I. C.	17	17	34	143	145	288	322
Soo Line	7	7	14	......	......	......	14
M. C.	15	14	29	......	......	......	29
C. C. C. & St. L.	4	4	8	......	......	......	8
Total	43	42	85	143	145	288	373
Grand total	293	298	591	380	372	746	1,337

commuters traveling between these points numbered 38,951,023, which gave 1913 a lead over 1912 of 1,474,991. Between San Francisco and Oakland, Alameda or Berkeley in 1913 the passengers numbered 34,731,918, the bulk of this traffic going via the Southern Pacific. Between

Daily Passenger Car Movement

Chicago Passenger Stations

Stations and roads	Through			Suburban			Grand total
	In	Out	Total	Out	In	Total	
Union—							
C. B. & Q.	133	126	259	151	135	286	545
P. C. C. & St. L.	65	65	130	....	....	....	130
P. Ft. W. & C.	119	115	234	32	19	51	285
C. & A.	64	66	130	....	....	....	130
C. M. & S. P.	205	139	344	60	53	113	457
Total	586	511	1097	243	207	450	1,547
Grand Central—							
B. & O.	40	40	80	7	6	13	93
C. G. W.	26	26	52	....	....	....	52
P. M.	37	37	74	....	....	....	74
Total	103	103	206	7	6	13	219
Total C. & N. W.	394	391	785	424	421	845	1,630
La Salle—							
L. S. & M. S.	139	138	277	88	89	177	454
C. R. I. & P.	75	104	179	174	166	340	519
C. I. & S.	18	12	30	....	....	....	30
N. Y. C. & St. L.	23	22	45	....	....	....	45
Total	255	276	531	262	225	517	1,048
Dearborn—							
A. T. & S. F.	46	54	100	....	....	....	100
C. & W. Ind.	....	....	....	31	29	60	60
G. T.	42	43	85	22	24	46	131
C. & O.	10	10	20	....	....	....	20
C. & E. I.	78	77	155	6	12	18	173
Monon	39	41	80	....	....	....	80
Erie	45	31	76	....	....	....	76
Wabash	58	43	101	6	8	14	115
Total	318	299	617	65	73	138	755
Illinois Central—							
I. C.	113	111	224	626	619	1,245	1,469
Soo Line	41	41	82	....	....	....	82
M. C.	118	105	223	....	....	....	223
C. C. C. & St. L.	26	27	53	....	....	....	53
Total	298	284	582	626	619	1,245	1,827
Grand total	1,954	1,864	3,818	1,627	1,581	3,208	7,026

San Francisco and Sausalito, 5,387,945 passengers were carried by the Northwestern Pacific. The Southern Pacific handled 19,716,931 of the 34,731,918 traveling between San Francisco and Oakland, Alameda and Berkeley.

DAILY PASSENGER MOVEMENT

Chicago Passenger Stations

Stations and roads	Through			Suburban			Grand total
	In	Out	Total	In	Out	Total	
Union—							
C. B. & Q.	2,195	2,200	4,395	7,120	5,140	12,260	16,655
P. C. C. & St. L.	934	1,218	2,152	....	....	....	2,152
P. Ft. W. & C.	1,329	1,482	2,811	498	303	801	3,612
C. & A.	1,227	1,404	2,631	....	....	....	2,631
C. M. & St. P.	3,568	3,568	7,156	1,644	1,618	3,262	10,418
Total	9,253	9,892	19,145	9,262	7,061	16,323	35,468
Grand Central—							
B. & O.	340	310	650	210	260	470	1,120
C. G. W.	185	306	491	....	....	....	491
P. M.	1,141	893	2,034	....	....	....	2,034
Total	1,666	1,509	3,175	210	260	470	3,645
Total C. & N. W.	8,300	8,511	16,811	17,000	15,583	32,583	49,394
La Salle—							
L. S. & M. S.	1,909	2,651	4,560	4,242	4,052	8,294	12,854
C. R. I. & P.	2,292	2,160	4,452	8,160	8,264	16,424	20,876
C. I. & S.	299	379	678	....	....	....	678
N. Y. C. & St. L.	368	326	694	....	....	....	694
Total	4,868	5,516	10,384	12,402	12,316	24,718	35,102
Dearborn—							
A. T. & S. F.	1,000	1,000	2,000	....	....	....	2,000
C. & W. I.	....	....	....	2,699	2,126	4,825	4,825
G. T.	631	635	1,266	1,172	1,175	2,347	3,613
C. & O.	240	215	455	....	....	....	455
C. & E. I.	1,750	1,745	3,495	300	400	700	4,195
Monon	442	420	862	....	....	....	862
Erie	450	450	900	....	....	....	900
Wabash	560	430	990	185	280	365	1,455
Total	5,073	4,895	9,968	4,356	3,981	8,337	18,305
Ill. Central—							
I. C.	2,365	2,525	4,890	20,696	20,061	40,757	45,647
Soo Line	410	404	814	....	....	....	814
M. C.	1,507	1,254	2,761	....	....	....	2,761
C. C. C. & St. L.	875	800	1,675	....	....	....	1,675
Total	5,157	4,983	10,140	20,696	20,061	40,757	50,897
Grand total	34,317	35,306	69,623	63,926	59,262	123,188	192,811

FACILITIES AND TRAFFIC AT PASSENGER TERMINALS

Summary of Terminal Data

	Station	Location	Type			Station building		Grade of tracks			Through trains daily	Trains originating	Trains terminating	No. of trains handled during busiest hour	No. of trains handled on one track during busiest hour	Est. no. of trains that could be handled during busiest hour	Est. no. of trains that could be handled on one track during busiest hour	Number and spacing of tracks	Number and width of platforms	Length of platforms	Height above top of rail	Are tracks on tangent or curve	Are switches interlocked
			Through	Headhouse	Over tracks	At end of tracks	Side of tracks	At streets	Over streets	Under streets											In.		
1	Dearborn	Chicago, Ill.		*		*		*			0	53	55	14	3	17	3	10 (see Plan)	See plan	670′	6	Tangent	No
2	D. L. & W.	Hoboken, N. J.		*		*		*			0	127	118	29	5	54	8	14-13′0″ C.-C.	8-20′; 1-17′	700′	6	Tangent	Yes
3	Erie	Jersey City, N. J.		*		*		*			0	123	126	28	8	33	12	10-15′0″ C.-C.	5-15′	650-700′	2	Tangent	Yes
4	Long Island	Long Island, N. Y.		*		*		*			0	135	134	60	5	65	12	24-24′0″ C.-C.	9-14′	760′	9	Tangent	Yes
5	Union	New Orleans, La.		*		*		*			0	11	11	6	2	12	3	4-24′0″ C.-C.	2-17′	704′	7	Tangent	Yes
6	Union	Cincinnati, O.		*		*				*	0	69	67	28	4	30	5	8	4-13′&15′	1-600′;3-650′	10	Tangent	No
7	Union	Louisville, Ky.		*		*		*			6	24	24	14	3	32	12	6-26′&20′ C.-C.	3-17′; 2-11′	450′-600′	6	Tangent	No
8	Union	Savannah, Ga.		*		*			*		10	8	8	....	....	....	......	9-14′ to 25′ C.-C.	4-15′; 3-10′	600′	7	Tangent	Yes
9	Union	Columbus, Ohio.	*				*			*	25	34	35	19	4	19	5	8-11′0″ C.-C.	1-11′; 3-17′	2:678′;2-774′	8	Tangent	No
10	B. & O.	Philadelphia, Pa.	*				*			*	20	14	14	6	3	12	4	6-12′&13′ C.-C.	2-23′; 1-12′	700′	0	Tangent	Yes
11	B. & O.	Baltimore, Md.	*				*			*	26	12	6	8	6	12	6	5-12′ C.-C.	Shed area	426′	0	Tangent	Yes
12	B. & O.	Baltimore, Md.	*	*		*	*	*		*	37	20	25	6	2	12	3	7-12′&50′ C.-C.	3-15′	610′	15	Tangent	Yes
13	Union	Peoria, Ill.	*				*	*			0	43	39	14	4	78	12	7	1-18′;3-12′;1-6′	480′	0	Tangent	No
14	Union	Troy, N. Y.	*				*	*			57	24	20	14	7	25	10	7-12′ C.-C.	4-12′	3-400′;1-310′	10	Tangent	Yes
15	Union	Albany, N. Y.	*				*				88	35	34	17	6	17	6	8	3-28′; 1-27′	650′-850′	6	Tangent	Yes
16	P. & R. Ry.	Reading, Pa.	*				*		*		32	14	14	12	3	30	5	....	1-20′; 2-15′	1,100′	8	Tangent	Yes
17	Penna. R. R.	Harrisburg, Pa.	*				*		*	*	55	47	45	8	5	30	6	8-12′ C.-C.	5-37′-22′	765′-860′	7	Tangent	Yes
18	Union	Birmingham, Ala.	*				*	*			6	20	20	....	....	....	......	10-12′ C.-C.	5-19½′	3-620′;2-770′	8	Tangent	Yes
19	C. M. & St. P.	Milwaukee, Wis.	*				*				22	30	32	12	3	20	6	5-13′&20′ C.-C.	Shed area	1,000′—max.	0	Tangent	No
20	Union	Minneapolis, Minn.	*				*			*	44	30	30	16	2	30	2	6-26′ C.-C.	Shed area	1,200′	0	Tangent	No
21	Union	Indianapolis, Ind.	*				*	*			46	42	40	30	4	37	5	8	Shed area	....	0	Tangent	....
22	Union	Toledo, Ohio.	*	*			*			*	43	39	40	....	....	....	......	13-12′ C.-C.	3-26′	....	0	Tangent & curve	No
23	Union	Nashville, Tenn.	*	*	*					*	10	26	26	11	2	15	4	10-20′&28′ C.-C.	5-20′; 4-11′	550′-750′	9½	Tangent	Yes
24	Union	Richmond, Va..	*	*		*	*		*		10	7	7	....	....	....	......	9-12′; 23′&13′	2-8′; 5-14½′	650′-1,248′	...	Tangent	Yes
25	Union	St. Paul, Minn.	*	*		*	*	*			92	46	46	42	5	42	5	14-26′&13′ C.-C.	8-16′	800′	12	Tangent	No
26	Union	Seattle, Wash.	*	*		*	*			*	6	35	36	....	....	....	......	11-12′ C.-C.	4-18′	200′	0	Tangent	No

* Indianapolis—Car storage yards 1/2 to 1 1/2 miles distant; except Pullman yard, 600 ft.

Summary of Terminal Data.—Continued

	Station	Location	Method of making up and breaking up of trains	Are engines changed on through trains	Are cars added or dropped, and why	Special arrangements for handling sub-urban traffic	Method of handling express and baggage	System of communication from despatcher to train conductor	Distance to engine house	Distance to car storage yard	If Union station, what is system of handling
1	Dearborn	Chicago, Ill.	Switch engines	No		None	Trucks	None	5 mi.	5.6 mi.	Owning Co. handles
2	D. L .& W.	Hoboken, N. J.	Sw. eng.&gravit	No		None	Trucks & cars	Through sta. master	1,800′	600′	Not
3	Erie	Jersey City, N. J.	Sw.&road engs.	No		None	Trucks.	Semaphores	800′	700′-4,500′	Not
4	Long Island	Long Island, N. Y.	Sw.&road engs.	No		None	Sw. eng. & trucks	Through sta. master	¼ mi.	¼ mi.	Not
5	Union	New Orleans, La.	....	No		None	....	Through despatch off.	....	....	Not
6	Union	Cincinnati, Ohio	....	No		......	Trucks	Telegraph	....	....	Sep. station employees
7	Union	Louisville, Ky.	Switch engines	Yes	Sleepers & diners	......	Trucks & sw. eng.	Telegraph	1,800′	2,800′	....
8	Union	Savannah, Ga.	Switch engines	Yes	Seldom	None	Trucks & floats	Telegraph	2 & 4 mi.	9,300′	....
9	Union	Columbus, Ohio	Yard engines	Yes	As traffic change	None	Trucks	Telegraph	....	....	....
10	B. & O.	Philadelphia, Pa.	Switch engines	Yes	Diners	None	Trucks	Station wire	1 mi.	....	Not
11	B. & O.	Baltimore, Md.	Yard engines	No	1 sleeper to N. Y.	None	Trucks	Through sta. master	2,500′	2,500′	Not
12	B. & O.	Baltimore, Md.	Switch engines	No	Occasionally	None	Trucks	Sta. mas. & tower	3,000′	2,500′	Not
13	Union	Peoria, Ill.	....	No	....	None	....	Through despatch off.	1½ mi.	Adj't	Sep. station employees
14	Union	Troy, N. Y.	....	Yes	No	......	Trucks	Messenger	1 mi.	1 mi.	Sep. station employees
15	Union	Albany, N. Y.	....	Yes	Yes, connections	......	Trucks and elev.	None	¾ mi.	Adj't	....
16	P. & R. Ry.	Reading, Pa.	Switch engines	No	Yes, connections	None	Trucks & cars	....	1 mi.	Adj't	Not
17	Penna. R. R.	Harrisburg, Pa.	Switch engines	Yes	Yes	......	Trucks and elev.	Through sta. master	4,150′	650′	Not
18	Union	Birmingham, Ala.	Yard engines	Yes	Yes, connections	......	Trucks and elev.	Telegraph	¼-1 mi.	¼-1 mi.	Not
19	C. M. & St. P.	Milwaukee, Wis.	....	Yes	Added; local ser.	......	Trucks and elev.	....	2 mi.	¼ mi.	
20	Union	Minneapolis, Minn.	....	No	As required	......	....	Telegraph	....	....	....
21	Union	Indianapolis, Ind.	Yard engines	Yes	Yes	None	Trucks	Teleg. & telephone	½-1½ mi.	½-1½ mi.*	Sep. station employees
22	Union	Toledo, Ohio	....	Yes	As traffic change	......	Trucks	Through despatch. off.	Adj't	Adj't	....
23	Union	Nashville, Tenn.	Switch engines	Yes	Sleepers & diners	......	Trucks	Telegraph	800′	800′	....
24	Union	Richmond, Va.	Switch engines	Yes	Yes	......	Trucks and elev.	Messenger	⅞-7.3 mi.	½-3.7 mi.	....
25	Union	St. Paul, Minn.	....	No	Yes	......	Trucks and elev.	Telegraph	½ mi.	½ mi.	Sep. station employees
26	Union	Seattle, Wash.	....	Yes	As required	......	Trucks and elev.	....	None	1,000′	....

* Indianapolis—Car storage yards ½ to 1½ miles distant; except Pullman yard, 600 ft.

Some interesting tables showing the daily passenger traffic in and out of Chicago, by train, car and passenger movements were compiled by Bion J. Arnold, consulting engineer, and included as a statistical appendix in his report on the Chicago Terminal situation presented to a committee of the city council on November 18, 1913. These figures, given herewith, showed that the Illinois Central handled the largest suburban traffic, with 40,757 passengers daily, the Chicago & North Western coming next with 32,583 and the Chicago, Rock Island & Pacific, third with 16,424. The Chicago & North Western handled the largest through passenger traffic with a total of 16,811 daily and the Illinois Central the largest combined suburban and through traffic with 50,897 daily.

A summary showing the total traffic in daily train, car and passenger movements by station groups is as follows:

SUMMARY OF RAILROAD PASSENGER TRAFFIC—TOTAL DAILY TRAIN, CAR AND PASSENGER MOVEMENTS

Chicago Passenger Stations

Stations	Through			Suburban			Total through and suburban		
	Trains	Cars	Pass.	Trains	Cars	Pass.	Trains	Cars	Pass.
Union	167	1,097	19,145	112	450	16,323	279	1,547	35,468
Grand Central	34	206	3,175	4	13	470	38	219	3,645
C. & N. W.	121	785	16,811	189	845	32,583	310	1,630	49,394
La Salle Street	80	531	10,384	111	517	24,718	191	1,048	35,102
Dearborn	104	617	9,968	42	138	8,337	146	755	18,305
Ill. Central	85	582	10,140	288	1,245	40,757	373	1,827	50,897
Grand total	591	3,818	69,623	746	3,208	123,188	1,337	7,026	192,811

The table on pages 198 and 199 was compiled by the committee on yards and terminals of the American Railway Engineering Association and presented at the convention in March, 1913.

Traffic studies are incomplete unless one includes those of New York City, which are a very good general guide as to what may be anticipated in other densely populated and rapidly growing centers. The population of what is now known as the city of New York, has increased more than fourfold during the past 50 years, and the number of people riding on vehicles of public transportation has multiplied by 30. A statistician of the Public Service Commission gives figures showing the percentage of increase of traffic by decades:

	Surface lines	All rapid transit lines	Total
1880 to 1890	45	347	109
1890 to 1900	81	Dec. 7.5	41
1900 to 1910	28	206	81

The drop in traffic on the elevated lines from 1890 to 1900 was due to the general electrification of the surface lines during that period, whereas the elevated roads were operated by steam until after 1900. The increased traffic beyond the proportional increase of population is ascribed to: Technical improvements in carrier systems. (This applies particularly to those on pleasure-seeking journeys—as to the seashore, theater, etc. Improved facilities, however, frequently tend to divert rather than increase traffic.)

Increasing number of visitors.

Greater activity of business men.

The same authority has worked out the population and traffic of the New York of the future, on the basis of present rate of growth:

	Population	Fares	Fares per capita
1900	3,437,202	846,353,058	246
1910	4,766,883	1,531,263,000	321
1920	6,578,000	2,473,000,000	417
1930	9,078,000	4,916,000,000	542
1940	12,527,000	8,810,000,000	703
1950	17,288,000	15,787,000,000	913

CHAPTER X

THE STATION MASTER

The larger joint passenger terminals that are used by a number of railroads are usually owned and operated by a separately incorporated terminal company. In such cases the management is placed in the hands of a terminal superintendent—sometimes designated as superintendent of terminals or manager—who reports to a board of trustees or directors or an executive committee which, in turn, is ordinarily composed of individuals representing the roads interested. A large passenger station, handling the business of but one road and possibly that of others as tenants, on the other hand, is usually placed in charge of a station master or manager who reports directly to an officer of the owning railroad company. In either case, the officer in charge, whom we shall term the station master for the purposes of this chapter, should be given autocratic powers. He must be required to produce effective results, and he cannot possibly do so unless he is given full authority to act without the handicaps of divided responsibility, red-tape, or the eternal bickerings on technicalities characteristic of the so-called departmental system of organization.

The various persons in charge of the terminal and its mechanical and electrical facilities, those in charge of track and signal maintenance about the station, those having supervision over the ticket, baggage, lunch and dining, lost article and parcel rooms and also those owning concessions, should be made responsible for their respective departments or rooms and should report to the station master. If the line approaching or passing the terminal is one on which only passenger business is handled, the station master should have full control over it and the contiguous interlocking plants for a sufficient distance out to enable him at pleasure to advance certain trains in preference to others. If both passenger and freight trains are operated over that portion of the line, conditions should determine whether he should control only the passenger service or both. If he has charge of the passenger business only, he should be allowed the preference as to the movement of his trains.

The station master, if he has been given full and sufficient authority, should be responsible for the service and conduct of train employees when they are at the terminal. The trainmen should be required to be on duty the designated time before the departure of their trains, properly uniformed, neat and clean, and at their various posts ready and willing to answer questions, to give needed assistance to invalids and old and exceedingly young persons, and to direct passengers to the cars they desire. Trainmen on incoming trains should assist passengers to alight and should never be permitted to leave until all the passengers are out of the cars and the baggage, mail and express are unloaded.

Instructions as to car ventilation should be given and enforced, there being kept in mind the troubles of the trainman or porter who tries to satisfy a car full of people, 10 of whom want the car cooled off; 10 probably want a little more heat; a few complain of too much air, while still others may think there is too little.

Nevertheless, an effort should be made to keep cars and waiting rooms at normal temperature with ample ventilation. The abnormal visitors and travelers can be more readily convinced by intelligent—always courteous—arguments when we are right in our actions.[1]

Regular rounds should be made daily to inspect generally the condition of the buildings and surroundings, the conduct of the employees and the service of the concessionaires. The station is, of course, being cleaned to some extent at almost any hour of the day. The thorough daily cleaning is best done, however, during the hours when there are no passengers about; ordinarily somewhere between midnight and five or six o'clock in the morning. It has often been found satisfactory to work out a regular schedule and to take the parts of the building in regular order or as the use of the various rooms permits.

Many of the station employees have little opportunity to leave their posts. A visit to them, therefore, often gives them an opportunity to consult the station master on various things that may come up and he in his turn gets a chance to see that they are doing their work in the proper way.

Those in charge of the restaurant, dining room, newstand, barber shop and similar "concessions" or conveniences, whether company employees or lessees, will pay more attention to details and render better service if they are visited regularly and frequently by the officer in charge.

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[1] The sanitary regulations of the Pullman Company deal with this matter as follows: Plenty of air gets into all cars that have exhaust ventilators, which should always be kept open. All other deck-sash openings should be kept closed. The drop-sashes of end doors should be lowered several inches at all times unless uncomfortable draughts are caused, as will happen only in extreme cold weather.

When people complain of poor ventilation they are nearly always too hot. Heat is being constantly formed in the body and is being constantly given up to the surrounding air. Ventilation always seems to be bad when people cannot give up their heat to the surrounding air as rapidly as it is formed in their bodies. When this happens, they feel drowsy and have headaches and "catch cold" readily. They think the air is bad and call for more fresh air. What they need is cooler air. The remedy lies in properly regulating the temperature of the car.

The thermometer in the car should never register above 70 degrees. It should be kept that low by reducing the supply of heat at the inlet valve as may be necessary. When passengers are in bed, the temperature should be kept above 60 degrees and should never exceed 65 degrees. Care should be exercised to avoid overheating the cars in the early morning.

The great essential of successful terminal management is the working out of a feasible schedule covering not only the arrival and departure of regular passenger trains but also the movements of drafts of cars, light engines, and those of mail, express, baggage and other cars. In making these schedules, the mistake is frequently made, under passenger department pressure or political influence, of arranging a service that cannot be successfully operated, or that can be operated only when all conditions are favorable. It is worse than useless, for instance, to attempt to turn a passenger engine back on another train during a busy part of the day and allow barely time for it to run to the engine house, be turned, watered, coaled and inspected, with all the involved train and engine movements absolutely on the minute. To attempt this in order, possibly, to economize slightly in service cost, only leads to demoralized service and invites criticism by the newspapers and the public. The average commuter is reasonable, but he is much better satisfied to leave on a train a few minutes later that moves with regularity, than to start on an earlier train that gets out on time only occasionally. He prefers to spend the additional time at his office or on the way to the station. Likewise, the traveling public generally prefers trains making good speed and running on time to those making very fast time and "hitting the mark" only now and then.

In arranging the terminal card, the train schedules proper should be fixed first and so adjusted as to render them practicable of operation. The engine movements to and from the engine house should then be dovetailed in, it being highly essential that the coöperation of the master mechanic[1] be obtained to secure the best results. The drafts of trains between the station and the storage yards may next be tabulated. In order to simplify the work and to reduce switching movements to a minimum, all unnecessary movements of engines and empty cars should be avoided. In stations where there is a large suburban service it is advisable to arrange for spot trains as far as possible. A "spot" train, it will be remembered from Chap. IX, is an incoming train that is used also as an outgoing train, being loaded where it has discharged its passengers on its inbound trip. The schedule finally completed, it should be put in print and a copy of it given to every person concerned, such as towermen, switchtenders, roundhousemen and platform and gate employees.

Where trains do not always run in the order intended, and where certain trains require different handling from others, a liberal equipment of train describers should be provided. These instruments have for many years been successfully used by the Pennsylvania Railroad. A towerman, telegrapher, or other designated employee at a point—usually a junction, several miles out—moves the pointer in his instrument around a dial to a name describing the train that has just passed. The pointer on the dial in the station master's office, and at such other places as have been equipped with train describers, moves to the same descriptive name. The dials have around their circumferences, such names as may be desired, as for instance, "New York Express," "Boston Limited," "Baltimore Local," or "Chicago Special." Each person interested then knows what train is coming and makes his arrangements accordingly. For busy roads, the telephone or the telegraph is too slow for this work and requires too much time on the part of attendants.

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[1] The master mechanic is in charge of engine-house operation and therefore responsible for despatching engines from the house.

Opening a large terminal is an extraordinary and unusual problem and very few operating men have had the benefit of that experience or the responsibility. For those who have not had it, and perhaps never will have it, the lessons to be learned from those who have met the problem will be valuable in their application to similar situations. When the Pennsylvania Railroad opened its station at Seventh Avenue and 33rd Street, New York, it had a condition that was unique in that no train had ever run in or out of the new terminal; it was wholly untried as far as track and station arrangement was concerned and entailed operation by electricity that was new in itself and to practically the entire force of employees who had to take over the station and operate it. The whole service had to start at once; there was no gradual changing from steam to electricity as was the case, for instance, in the Grand Central Station. Not only the station and yards in New York but the four tubes under the East River, the two lines under the North River, the change from steam to electric engines or *vice versa* at Manhattan Transfer, the operation of the Sunnyside terminals with all their attendant facilities—all had to be started at the same instant and, one might say, in full blast. The mode of solving this problem was unique and ingenious. As stated elsewhere, about two weeks before the actual opening of the great station and its many miles of underground, under-river and surface roads and connections, the entire service was put in operation just as it was expected to be operated regularly for passengers. Every train was run; every engine was cut off or added (both steam and electric); every man was at his post—trainmen, yardmen, inspectors, etc.—train sheets were kept, delays recorded and explained—in fact, there was only one thing missing, the business, including the coming and going passengers with their impedimenta, the mails, and the express. Engines were changed at Manhattan Transfer as afterward; inspection of trains was made and an even closer record of time kept than later because the results were used largely as a basis for the final train operation schedules under which the movement was to continue. Every train was run with the same number of cars as when normal operation was going on, wherever it was possible the same kind of cars were used, but in every instance care was taken to reproduce the exact number and weight of cars.[1] It was probably a source of wonder to many of the first travelers—if they did any thinking at all—that the train movement started off so smoothly.

In another large terminal which was opened in a new location with an entire transfer of service from the abandoned stations, the problem was met in an entirely different way. There was in this case no electrification or its accompanying complications to contend with. As there was ample room—it being an extension and increase of facilities—the difficulties were not so great as in the case of the Pennsylvania's New York Terminal. Nevertheless, the task was delicate and exacting—and *new.* The operating officers constructed a miniature replica of the entire terminal, showing tracks, switches, signals, platforms and all the other essential parts used in connection with them. This was placed on supports at a convenient height in one of the large rooms of the terminal. A month or more before the opening of the station for general business, the station master and his assistants, including the signalmen and all those to be connected with the operation of the terminal, met and proceeded to reproduce the actual operation by using blocks representing the cars and engines. The new time-table had been arranged and for several days and nights every engine, draft, switching, yard or regular movement was made on the reproduced combination of tracks at the actual time scheduled, each being allowed to consume the full time necessary for its completion. As was to be expected, this being the purpose of these preliminary performances, the "war-play" showed certain combinations, principally during the hours of heaviest movement, that were geared up too closely. These combinations were then readjusted, tried out and readjusted, until they worked out smoothly and to the satisfaction of those handling the miniature railway. It may have seemed like playing with toys but in reality the end justified the means.

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[1] The reader who wonders where the railroad could secure the necessary motive power and equipment will understand that the electric engines were newly purchased for use only over the new section, and that as the run from Manhattan Transfer to Sunnyside Yard is only about 10 miles not many cars would be needed.

CHAPTER XI

THE TICKET OFFICE

The ticket office—the first thought of most passengers entering the average railroad station—is frequently an after-thought of the architect as can easily be proved by an inspection of many stations wherein the ticket offices show a lack of consideration on the part of the designers, as regards both location and the provision for taking care of a natural increase of business.

As has been emphasized before, the ticket office should be placed where it will naturally be sought by passengers on their way to their trains. In most stations this means that it will be placed with its windows facing on the waiting room. In other cases, and particularly those which are so arranged that all passengers need not use the waiting room as a passageway to their trains, the windows may open upon the concourse, the entrance hall, the waiting room itself or upon a so-called ticket lobby in which the ticket office is the most important facility. The office in any case should be so located that patrons, after having procured their tickets, will move away from the windows of their own volition and not block the way for others. It has been noticed that passengers tend to group

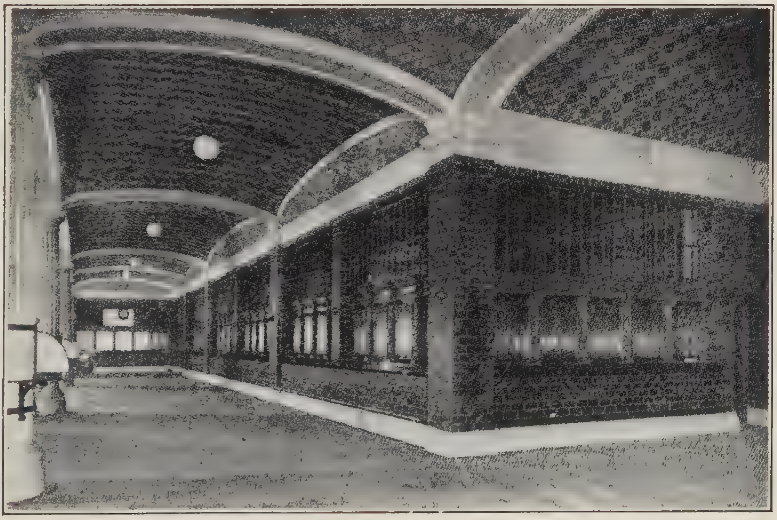

Fig. 130.—Ticket offices in North Western Terminal, Chicago.

in a waiting room or concourse on the side toward the tracks. If the ticket office is likewise located on that side, as was the case in the old Grand Central Station in New York or the new Albany station, congestion and confusion will result. It is to be noted that the ticket office at Albany was afterward moved to the other side of the waiting room and that the four offices at the new Grand Central Station are on the opposite side of the concourse from the platform gates. That the ticket office be near the baggage room is of major importance in any station and especially so if the amount of through business is large. It is essentially bad design if the passenger must retrace many of his steps in going from the main entrance to the ticket office, thence to the baggage room and from there to his train.

It is most important to allow for growth of business, not only by first making the office of ample size with spare windows if necessary but also in so placing it that it can be enlarged without relocation or without seriously interfering with the design of the building.

It is a well-known fact that employees are more pleasant and cheerful while working amid agreeable surroundings, and there is no doubt of their greater efficiency in a light, airy, well-ventilated office than when cooped up in one which is dingy, artificially lighted and ill-ventilated. If possible, therefore, the ticket office should be placed where it will have the advantage of natural light during the day. Great care must be taken to avoid drafts through the ticket offices, for if there are drafts through the windows it will probably be necessary to provide a glass partition with a speaking hole in it. This is a decided disadvantage. The average ticket purchaser is rattled enough when he steps up to buy his ticket; if he has to speak to the clerk through a small hole in a piece of glass he will only be doubly confused. This is one of the disadvantages of the ticket office at Boston South Station. There are windows opening on both the concourse and the waiting room, but for that reason there is a decidedly strong current of air through the office on windy days, which is a pronounced inconvenience. The trouble is partly overcome by a vestibule with a considerable number of doors which is put in service in winter in front of the ticket windows on the concourse.

As a rule, it is not advisable that a station have more than one ticket office. There are many cases, however, where it is not only advisable but necessary, that there be two or more offices, as in the Pennsylvania or Grand Central Terminals in New York where the through and local business is handled in widely divergent parts of the terminal and on different levels. The idea that has been carried out in the Grand Central Terminal of having, in addition, separate offices on each level for the New Haven and the New York Central is likewise commendable, where there is sufficient business to justify a separation of utilities.

The number of ticket windows in any office will depend upon the size of the office and the space allowed, the provision for future growth, the system of selling tickets adopted (as noted below), the amount of business handled, particularly in the rush hours, etc. For like amount of business there should be more windows for local than for through traffic. The through tickets are bought in large denominations whereas the local tickets are not. The considerations as to the size of the office are the same.

Ticket sellers who have worked under varying conditions generally agree that for station work a comparatively narrow wicket is to be preferred to an open counter or a wide window. The best width for most purposes has been found to be 2 ft. 3 in.

The width of the ticket counter is a small thing, perhaps, but it adds much to the comfort of the seller if the counter is wide enough on the outside of the office to keep the passengers at a distance and narrow enough inside so that the ticket seller can easily put the ticket and the change beyond the grill.

The height of the ticket counter is likewise a small thing but it does appear important when it is considered that if the counter is too high the ticket seller will have to lift his hand 2 or 3 in. more than is really necessary 2,000 or 3,000 times a day, or that if it is too low, he may acquire a stoop. Local tickets have to be sold with particular speed. A counter of improper height may thus be a check to efficiency. A counter 3 ft. 8 in. in height suits the average requirements.

The size of the ticket counter and its height from the floor depend somewhat, of course, upon the class of tickets sold. The counter for coupon work, when there is much writing to be done should be wider inside the grill, and somewhat higher from the floor than a counter used wholly for local ticket selling. The most approved plan, however, for the handling of coupon tickets is to provide an auxiliary counter or desk, termed an "island counter" not quite directly back of, and about 4 ft. away from the ticket window. It is most annoying and disconcerting to the ticket seller, when he is writing up a complicated tourist ticket—which, on account of its length, ordinarily projects outside the grill a foot or two—to have to endure the comments of waiting passengers. Under these conditions, moreover, he cannot do his best and is likely to make mistakes.

A series of experiments conducted not long ago at one important terminal indicated that the best material for ticket counters, particularly where mostly local tickets are sold, is plate glass, painted black on the under-side and properly imbedded and protected against breakage. Wooden counters are in use in many stations, but they have a number of disadvantages. It has been found, for example, that passengers are far less likely to leave change on the glass counter than on the wooden counter on which the coins are more or less concealed by the greater similarity in color. The wooden counters, also, are very prone to become moist and sticky on damp days with the result that the tickets do not slide over their surfaces, thereby causing inconvenience to sellers and patrons on a day when they should be inconvenienced least. It is true, also, that a bad coin falling on a hard substance like glass is readily recognized by its ring. Glass with the black under-surface has the advantage of reflecting a minimum amount of light into the eyes of the ticket seller or his patrons.

The use of a glass shelf so hollowed out that a passenger may quickly scoop up his change without removing his gloves saves its first cost many times, especially at busy points, as it enables the passenger to move on quickly and the seller to serve more persons. There is such an arrangement patented and manufactured, and while it is sold at entirely too high a price, it, nevertheless, possesses much merit.

The grill work usually placed before each ticket window serves the very useful purpose of permitting the ticket cases, particularly those containing the racks for local cardboard tickets, to be placed immediately adjacent to the counter in the most efficient position. At the same time, they guard the tickets from unscrupulous persons who might otherwise be tempted to reach in and steal. The grill is much better than the pane of glass commonly used in theatre ticket offices, because it brings the buyer and seller into better contact with each other with advantage for all concerned. The grill, likewise, allows the buyer to be more at ease, no small item as far as the efficiency of the office is concerned.

Grills should be made of thin upright metal rods finished dull black. Most grills of other form or color interfere with the ticket clerk's vision and it is a decided disadvantage of bright brass or similar grills that they reflect light into the eyes. The dull black finish reflects little or no light and can very easily be kept clean.

Railings outside of ticket offices are of doubtful value; and if the ticket windows are near together in a row railings are a decided inconvenience.

It is almost essential that there be a baggage rack of some kind running along beneath the ticket window at about knee height from the floor. Passengers find it much more convenient if they do not have to stoop to put down or pick up their baggage and, of course, the time they would otherwise spend in those motions is so much saved. They are also much more at ease when their suit cases are so much more within reach and they can give their undivided attention to purchasing their tickets. The presence of a baggage rack likewise tends to keep parcels off the ticket counter. The kind of rack installed, if there is one, should be in keeping with the surroundings. Polished brass racks have been found especially useful and pleasing in many cases.

The office furniture, the ticket cases, the storage cabinets, and other accessories should be of simple and substantial design, not only for security and economy but also for the sake of cleanliness. Steel equipment has now been placed in common use, and is to be recommended for its fireproof qualities.

It is the usual plan in most offices to have a single stock of interline tickets and separate stocks of local tickets for each ticket seller or window. It is quite practicable, but not necessarily advisable, to have a single stock of local tickets in an office where there are but two or three sellers. There is usually a loss in efficiency, however, if two or more clerks have to work from one stock of local tickets. The plan usually adopted in such cases is to have an individual dater, which in the act of stamping cuts off a part of the ticket for the clerk's cash record. In one office where this idea is in force, it is the usual thing to find the ticket sellers walking 15 or 20 ft. to procure certain local tickets. There is a loss of time and about the only saving is in the printer's bills for the surplus stocks which each clerk would be compelled to carry if he were supplied with an individual set of tickets.

In some offices there is a separate stock of local tickets for each ticket window. If the office is small the day clerk and night clerk may each work at the same window, care being taken to give either sufficient time to check in and out. At the two Boston stations (North Station and South Station) and at many others, each clerk selling local tickets has an individual stock, a regular window and a cage to which no other clerk can have access unless the entire account is transferred. This is easily the best way to handle the selling of local tickets, as is at least partly shown by its success at the above stations and in the New Haven ticket office of the Grand Central Station where the idea is also used. The idea has several adaptions. Thus at one station the individual cages are put on rollers, space being provided for the storage of the extra ones.

It is usually impossible at any important station handling from 500 to 2,000 forms of interline tickets to have a number of individual stocks. If there is ample room, however, and the number of forms is not too great, the idea may well be carried out. The plan is in use at the New Haven office at the Grand Central Station and has been found most satisfactory. At several ticket offices a distinct separation is made between local and through business. In the South Station at Boston, for instance, there are 11 local windows on the plan mentioned in the previous paragraph. There are five windows handling interline tickets, but although each clerk has a supply of many of the local and interline tickets most in demand in the case at his window, the real interline stock, consisting of something like 1000 forms is in the large case behind him to which all five clerks have access. There are no individual cages, therefore, except the one which surrounds the interline section of the ticket office. At some stations, the separation of local and through business is not so well defined. At Worcester, Mass., there are five ticket windows; each clerk has an individual stock of local tickets and individual cases, but the large stock of interline tickets, something like 1,500 or 2,000 forms, is in one case to which all five clerks have ready access.

It is usually desirable in any terminal not to make the division between local and through ticket selling too well defined. The clerks selling local tickets should be able to sell also those interline tickets for which there is a very heavy demand and *vice versa.*

Most ticket sellers prefer coupon cases, in which the tickets are hung, to drawer cases in which the tickets are laid out flat. The drawer coupon ticket cases have several theoretical advantages. They are supposed to keep the stock clean and to be deep enough to keep all the tickets of each form together. In practice, however, it has been found that dust accumulates in the drawers, and that the drawers are never long enough for some of the forms and not deep enough for others. It seems to be as necessary to use a stock cabinet for surplus tickets, with drawer cases, as with hanging racks, although this is one of their supposed points of superiority. It is certain that tickets can be found and taken more quickly from a rack than from drawers, and that it is also easier for two or more sellers to work from a rack, at one time.

The cabinets for surplus stock should be divided into separate compartments with individual keys for the various stocks. The location of these cabinets is often a problem. In a number of offices where space is valuable a mezzanine floor has been provided.

Each person handling cash should have a compartment for his funds in the office safe. The compartment, of course, should have either a combination or key lock. The latter is usually found preferable.

There are two seemingly unimportant matters which deserve far more consideration than they receive. The ticket office, as has been said, should be among the most accessible facilities in the station which it serves. If it does not lie directly on the line of movement between the streets and trains, there should be prominently displayed signs which will direct the passenger and save him all unnecessary inconvenience. It is also most essential for the sake of the efficiency of the ticket office and the feeling of the patron that the local, through or Pullman ticket windows be clearly indicated. There should also be some very clear indication showing whether the office be opened or closed. It is not sufficient that the window be unoccupied or that it be closed. One can strongly recommend, therefore, the idea carried out at the Grand Central Terminal in New York. There is a prominent lighting fixture directly over the window on the outside. If the window is in service, the light is on and it is very clearly indicated from the lettering on the shade in what service the office is engaged.

A small detail but one quite likely to cause complaint and possibly a loss of revenue is the failure to locate one or more clocks so that the passenger in the line at the ticket windows can readily ascertain the time without having to look at his watch—thus holding the line whereby the patrons fearing that they are late will stampede for the trains earlier than is necessary without buying their tickets.

The personnel of the usual large ticket office consists of: an agent, an assistant agent or senior clerk, an accountant, the ticket sellers and possibly a stenographer.

In many stations, the agent has control over the men in the information bureau. The agent usually reports either to the chief officer of the terminal, the station master, terminal superintendent or whatever the name may be, or else to the division superintendent in the case of smaller stations. He should have sole charge of the ticket office and in some cases has the power to hire and discharge the men under him. The assistant agent may be a senior clerk upon whom in the absence of the agent the latter's duties devolve. All of the clerical force in the office handling money must be bonded, preferably to the agent.

The work of a ticket office may be classified thus: ordering tickets; recording stock received; arranging tickets for selling; selling; daily recording of sales and cash; depositing funds; making reports to auditor; and miscellaneous work such as correspondence and the like.

Tickets are usually ordered by the bookkeeper or accountant, subject to the approval of the seller. Upon receipt of the tickets, they are recorded and charged to the seller who then becomes accountable for them as though he were the ticket agent at any small station. At the close of each day's work, the seller files with the accountant a list of the cash on hand. The ticket numbers are then drawn off, and the amount of the sales figured by the accountant, the result being compared with the amount of cash reported on hand. The sales are charged against the seller by the cashier who then draws on the seller for the amount of his debit, credits the seller with payments and deposits the funds. The accountant renders a monthly report to the auditor. The totals are also referred to the cashier who draws up the balance sheet.

The first element in the successful operation of a ticket office is the selection of its head. Assuming that the right man has been chosen, it then becomes the duty of his superior to see that he has the proper facilities for doing his work, these being good office equipment, and even more important, means of selecting his subordinates so that desirable recruits may be obtained and held in their positions, not only long enough to become familiar with their work, but long enough for the railroad to have the benefit of their experience.

It is essential that the man in charge of a large ticket office be closely in touch with, and have the entire respect and confidence of his superior officer; and it is equally essential that the superior officer be closely in touch with the agent. It is, therefore, very desirable that there be a system of inspection which results not merely in criticism, but in more efficient service. It is not enough, when mistakes have been made, or poor service rendered, for the superior to take the subordinate to task, but both must agree on the general methods best suited to secure the desired results.

To be successful, an agent's views must extend beyond his own line of duty. He must inquire into the reasons for everything he does. He should study to eliminate all useless operations, and to acquire methods which will facilitate his work. He must be able to see and adopt useful methods devised by others, and also to originate for himself.

Experience with about 50 employees in the ticket office of a certain terminal has shown that there is no difficulty in securing men who can work fast enough. Most of them, also, are accurate enough for practical purposes. The thing most difficult to secure, however, is courtesy; and it is the most useful. No quality which a man can possess—save honesty —is as valuable in a ticket office. Patrons of the road will overlook mistakes of all kinds, but if they are discourteously treated, they cannot forget that.

Lack of courtesy is not always intentional. Many passengers are unable to distinguish between courteous, quick treatment and that which is abrupt and discourteous. Operations at ticket windows are necessarily conducted with speed. There are times when, without saying a word, a ticket seller can give a passenger what he asks for so quickly that the passenger thinks the ticket has been "flung" at him. One passenger will appreciate this rapidity, while another will not. The ability to hurry when necessary, and to take plenty of time when he can, is very useful to a ticket seller, and should be cultivated.

To secure best results, it is necessary for a clerk to put himself in the place of the passenger. Nearly everyone who asks a question has a good reason for it, or at least, thinks he has, so the ticket seller cannot afford to treat any seemingly useless question otherwise than as most important. It must be borne in mind, also, that one can insult as deeply by a look or gesture, as by a word. It should be realized that similar replies may create dissimilar impressions on different individuals. The language of a reply is one thing, and the idea conveyed by it, another. The point is to convey the proper idea.

The Baltimore & Ohio not long ago gave an award of $25 for the best paper submitted by its agents on "How a Ticket Agent Should Handle an Undecided Caller." Elias Bernstein, the winner, agent at Pleasant Plains, Staten Island, said in part:

> "Whether it be on the road with the merchandise or behind the ticket counter, the salesman must have at his command a thorough knowledge of his business and an understanding of human nature.
>
> "It is a great art to handle a man in such a way as to win both his trade and

his friendship. A living man is the most complex piece of machinery in the world. Compared to him, a locomotive is a play toy. The slightest blunder may cause him to work badly or to break down; yet there are no printed directions attached to him. All we can do is to watch his eyes and do our best.

"Now let us suppose a case of an undecided caller. He wants to know what advantage our road has over another which also runs to his destination. Certain golden rules must be closely adhered to. The first greeting from the agent must be a sunny smile. He must listen attentively and study the brand of information desired.

"Since first impressions are very lasting the company's servant must have at his fingers' tips the facts and figures. It must also be kept in mind that it is easier to win a man through his eyes than his ears. Diagrams and maps are very helpful and speak for themselves. You can never win a man by talking at him; you must talk with him."

It is sometimes a revelation to see a ticket seller deal with a stranger—one who is hard to suit—and immediately afterward, with one of his own friends. The safe course is to treat all like friends.

Children, foreigners and the ignorant should be given every attention.

Teamwork between the clerks should be insisted upon. It is often best to discharge a clerk who, even though he may have every other attribute of a successful seller, lacks the essential ability to get along with his fellows.

The good reputation of an office depends upon the faithful representation of the ticket agent by his subordinates. The reputation of the clerks, on the other hand, depends largely upon the reputation of the office.

Each clerk should understudy the duties of the other clerks so as to be capable of filling their places when required so to do. By such means alone is it possible to maintain service.

Although it is not as evident as it might be in all our large terminals, the information bureau has developed into one of the most important branches of passenger terminal operation. A well-managed information desk, with adequately trained, courteous and tactful attendants to serve it, is a big asset, as a creator of good will, to all the station's users, railroads and patrons alike. In great measure, also, it relieves the ticket office and the ticket agent of a great burden by being in a position to answer questions not pertaining primarily to the price of a ticket or the reservation of a chair or berth. Until recently it was the custom for the information bureau to be conducted as a part of the ticket office and to be in or adjacent thereto. In many instances this holds true today. In some stations one of the ticket agents, usually he who sells the chair car seats or sleeping car berths, performs the service in addition to his other duties. There are some stations also in which the parcel room attendants serve as the information bureau. In the larger and more recently built terminals, as for example, the two new ones in New York, the information bureau is quite apart from the ticket offices. Its attendants are men carefully chosen for their personality and judgment and not only for their knowledge of schedules and fares but for their knowledge of people. They are carefully trained to answer almost any conceivable question and usually as a crew they can answer questions in almost any conceivable language. Not the least of their activities is the answering of inquiries received over the telephone, more than one information bureau requiring a switchboard for this part of its work. All information desks are stocked with all sorts and kinds of passenger-department time-tables and bulletins, city guides, shipping instructions, sailing dates of steamers, and in many of them detailed information is received by telephone or telautograph of any important delay, accident or similar occurrence.

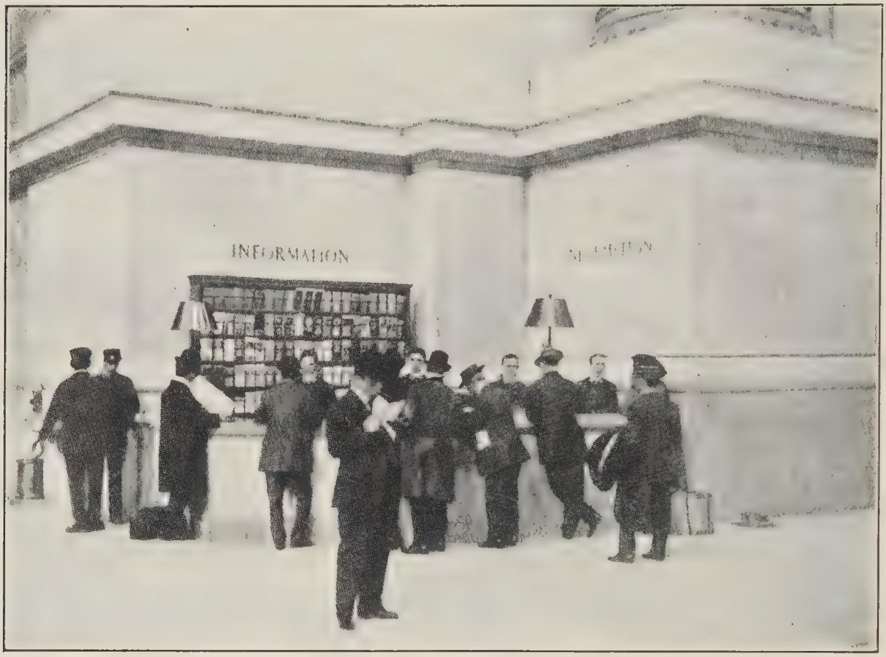

FIG. 131.—Information bureau, Pennsylvania Terminal, New York.

CHAPTER XII

TRAIN INDICATORS

There are about an even half dozen general types of machines or devices in use for the purpose of aiding the intending passenger to find his train after he has bought his ticket and checked his baggage. There are many more modifications, as well, brought about partly to meet unusual conditions and partly to satisfy the whims of æsthetic and imaginative general passenger agents.

The simplest form of indicator is that showing on a plain blackboard the train number, and its departing time, and perhaps also the train's name, its general or final destination, and the stations at which it stops. The trouble with these boards or cards is, however, that they are inconvenient to handle, that great care must be taken to keep them from getting lost, that the stock of cards is bulky and that rarely, if ever, can signs of this kind be made or kept attractive and clean. Those are the reasons that more expensive devices have come into general use.

There is a simple and effective system in use at the New York, New Haven & Hartford station in Providence. A large black-faced clock dial with white hands is provided for each general stairway or subway entrance. To the right of the dial is shown the track number to which it refers; and this number may be changed, so that one dial may direct to any desired track. Below the dial is a frame into which a board is placed giving the destination of the train, a list of the various stations en route and reference to important connecting trains. The dial hands are turned by the attendant by means of a convenient knob to indicate the hour and minute of departure of the train involved. The attendant then places the sign boards showing the track number and the train's stops in their respective frames. This indicator is particularly adaptable for locations covering two or more tracks.

At the North and South Stations in Boston, the Lackawanna Station at Hoboken and many other large terminals, the indicators are of a type whereby one machine covers one and the same track and the stations at which the train stops are shown on three-sided slats so arranged that only the names of those wanted are turned to the front. Views of indicators like these are shown in Fig. 97. A diagram of the card used and a vertical section are shown in Fig. 132.

The three-sided slats are blank on one side and have the station names on the other two. Each is revolved by a quadrant and pinion gear,

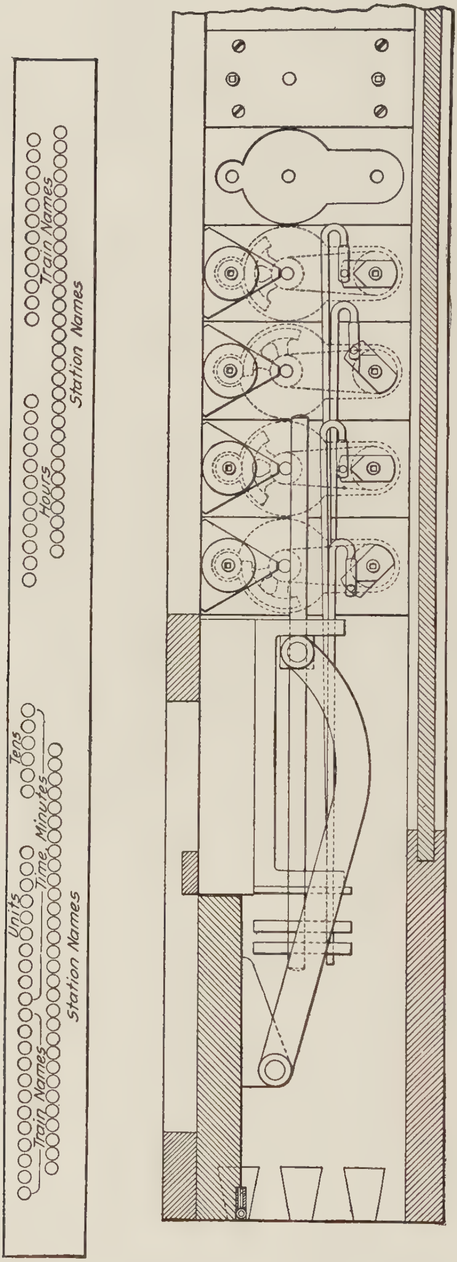

FIG. 132.—Card and vertical section of Boynton indicator.

driven by a chain from a rocker shaft to which a vertical wire is connected by a bell crank. The lower ends of the wires are centered over holes in bed plates extending the width of the machine. These plates are raised by closing the door at the bottom of the indicator. A stiff perforated cardboard is laid on one of the bed plates. Where there is a hole in the card, the wire passes through as the plate is raised and the slat does not revolve. Where no hole is punched, the card lifts the wire and moves the slat. When the card is laid on the upper bed plate, the slat is turned 240°; when on the lower only half as much. There is a separate card for each train, and one can be used until the schedule is changed. In the drawing there is shown a card for an indicator in which there are two columns of station names. The card has 60 name spaces, so that with three-sided slats 120 stations can be shown (by putting the card on the upper or lower bed plate) or 180 stations if four-sided slats, with three bed plates, are used. The card shown has also spaces for train names, which are on revolving slats, and for time, the hours and minutes being on slides and the time shown by lifting the proper slides according to the combination punched on the card. The name of the railroad is on a revolving cloth curtain which is not operated automatically.

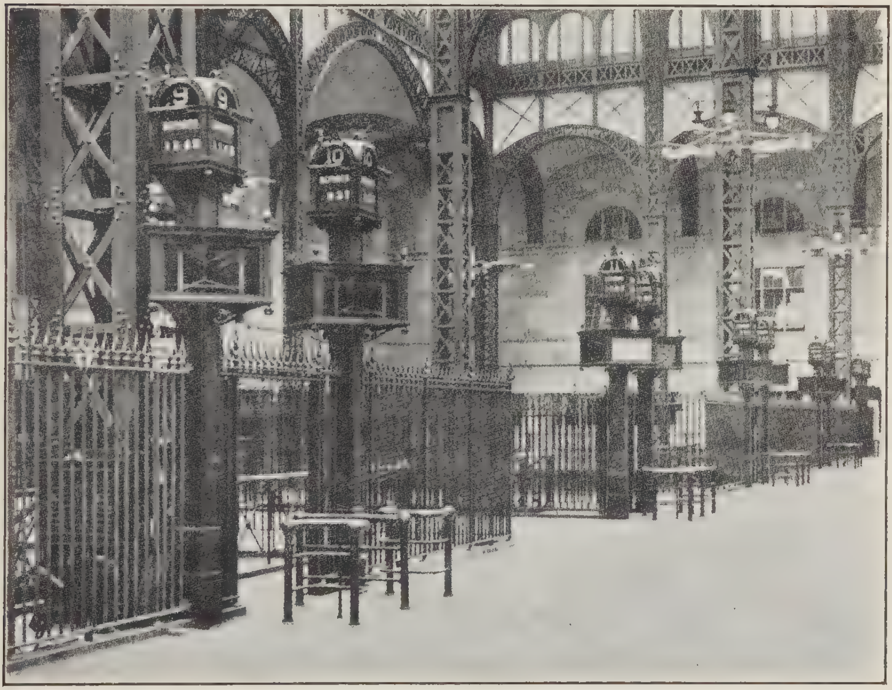

FIG. 133.—National indicators in Pennsylvania Station, New York.

Each quadrant and pinion is enclosed in a separate wooden box. The cogs at three points on the quadrant and the pinion are replaced by smooth surfaces, convex and concave, respectively. These lock the slat in position, and also allow enough play to compensate for errors in adjustment of the operating wires, which, if ordinary gears were used, might leave the visible side of the slat out of parallel with the front of the indicator. Each slat may be removed for relettering without disturbing the rest of the mechanism. These indicators are from 3 ft. to 6 ft. in width, 8½ to 9½ ft. in height and 7 in. thick.

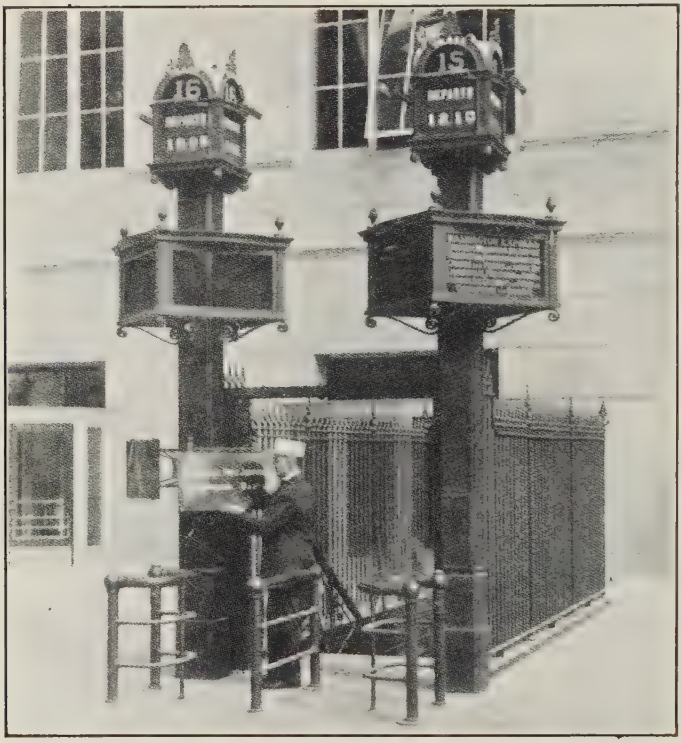

FIG. 134.—Method of adjusting indicators shown in Fig. 133.

The most modern indicators at the present time, however, are the Hutchinson indicators made by the National Indicator Company of New York. They have been installed in the greater number of the new and larger terminals, and are in service at the following and other stations: The Grand Central and Pennsylvania Terminals in New York, the Michigan Central Station in Detroit, the Great Northern Station in Minneapolis, the Central of Jersey Station at Jersey City and the Union Station in Kansas City.

The indicators at the Pennsylvania terminal are somewhat out of the ordinary. As will be seen from the illustration in Fig. 133, they form a part of the fence along the concourse and fit in with the artistic scheme of that facility. The indicators are of cast iron and about 16 ft. high. The sign cards, 17 by 32 in. are made of aluminum painted red. They are large enough to display not only the name of a train, but also its principal station stops. The cards of the indicator are carried on a light frame, inside of the larger frame, and this inner frame is lowered by means of a small crank inserted in the hole near the base of the post. The movable parts are operated by five ½-in. shafts, by means of miter gears and universal joints. The track number at the top is illustrated from within, but the rest of the lettering is illuminated by outside reflectors. The numerals used for showing the time are on their steel ribbons, enameled on both sides. A single crank serves to move both the name card and time ribbon. At the Pennsylvania Station there are 44 of

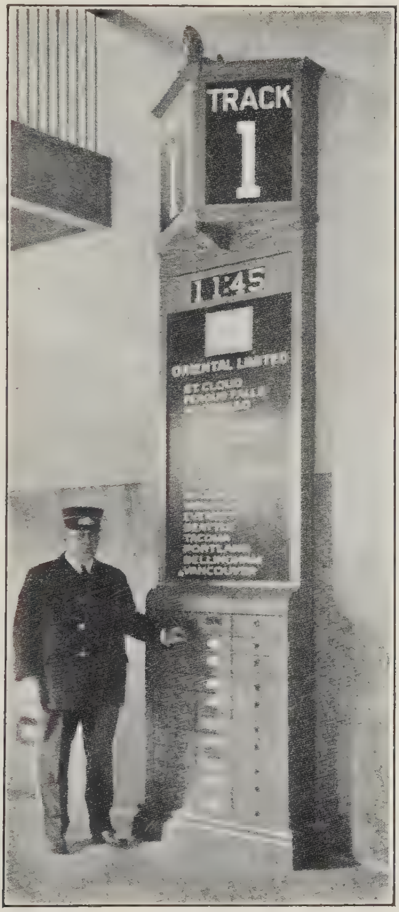

Fig. 135.—National indicator in Great Northern Station, Minneapolis.

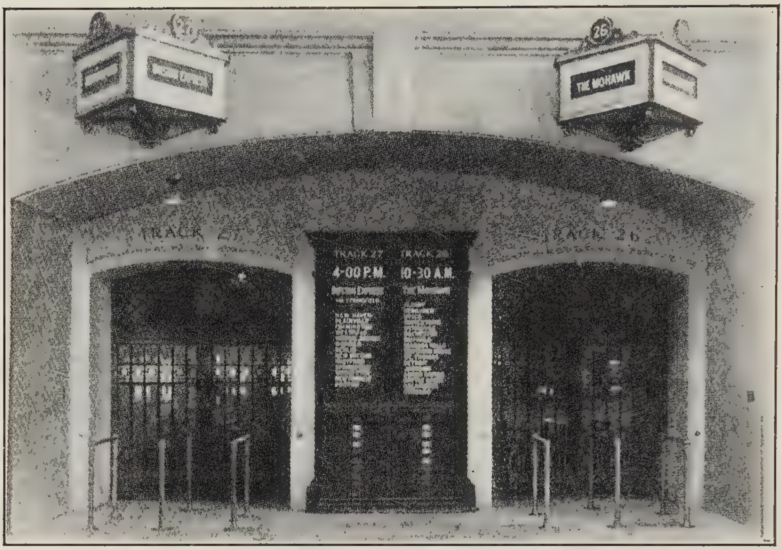

FIG. 136.—National indicators in Grand Central Station, New York.

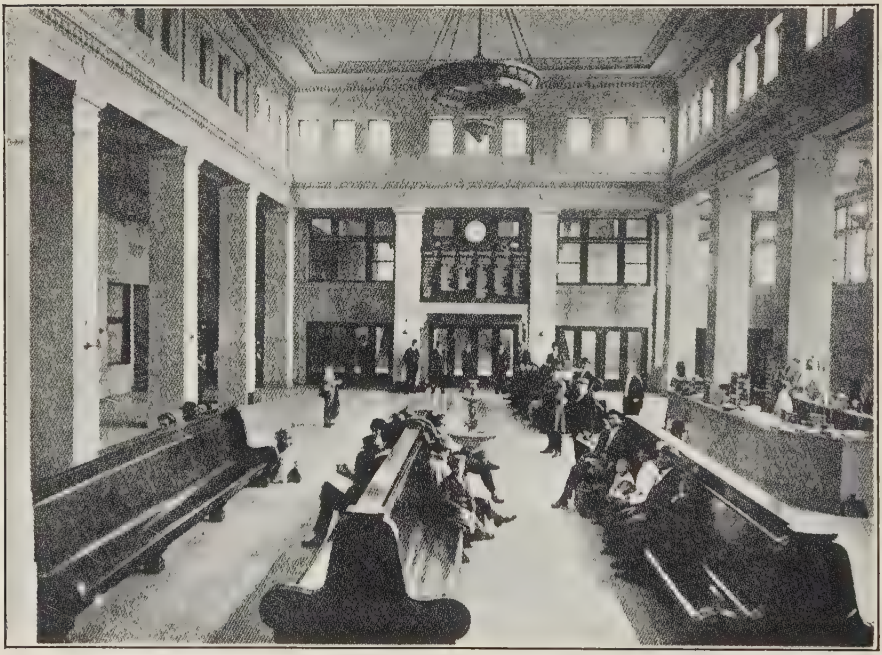

FIG. 137.—Train indicators in Illinois Central Station, Memphis.

these indicators. In the Grand Central Terminal two general types of Hutchinson indicators are used, one, as seen from the illustration in Fig. 136, showing indications on two faces at right angles, and the other, shown in the same figure, having only one flat surface. Indicators of the former type are used on the upper level and in each case where one is used there is also another of the flat type used with it. On the lower level where the decorative scheme is simpler only indicators of the flat type are used. The faces of the upper indicators in Fig. 136 are 26 in. by 40 in. in size, the opening being about 10 in. by 30 in. The figures in the round disk in the ornamental top show the number of the track. These indicators are made of metal heavily coppered.

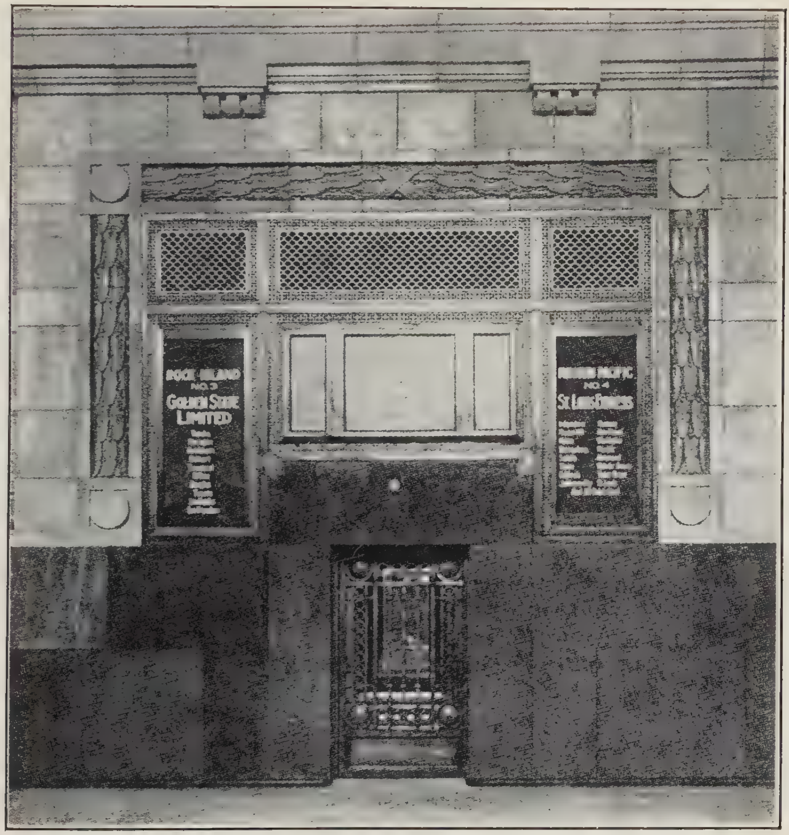

Fig. 138.—Indicators in Kansas City Station.

The flat indicator shows the names of the stations at which the train stops and is set at the side of the gateway. The lettering is simple and effective, there being plain white letters on a solid dull black ground. These letters are painted on black curtains, all of the curtains likely to be wanted at a particular indicator being rolled on sticks, like curtain rollers, and kept in the drawers in the lower part of the indicator. To display the bulletin of a train the roller bearing it is put in position at the bottom of the space alloted to the curtain, and its upper end is drawn to the top of the space by means of endless chains, one on each side, which when moved by the attendant unroll the curtain its full length, displaying the names. The operation takes but 10 or 15 seconds. The section of the indicator containing the drawers is about 3 ft. 6 in. high, and the mechanism for turning the chains is in a space about 10 in. high immediately above this. These indicators in this case are 11 ft. high, and from 32 to 40 in. wide, but they are also made of 22-in. width. The curtain is made of black, waterproof rubber-faced drill and it is about 5 ft. long. The curtains are the same size and color as the space they cover and as, when stretched, they lie flat, the appearance of the indicator when empty is precisely the same as when in use, except for the absence of all the lettering but the track number. The manufacturers of these indicators also supply curtains of other colors than black.

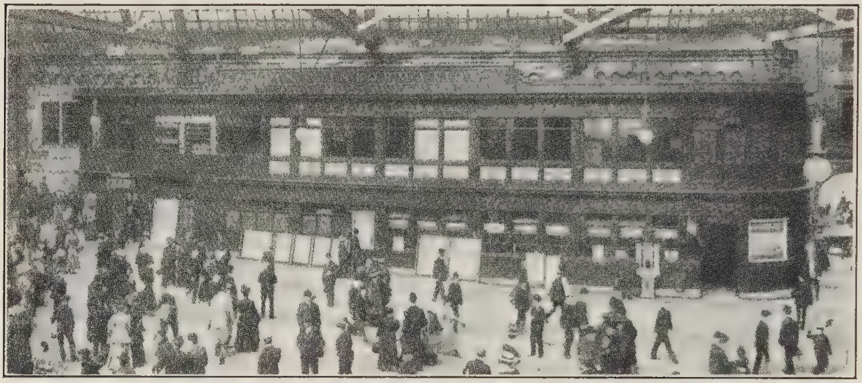

Fig. 139.—Method of announcing trains in Central Station, Glasgow.

Foreign practice with relation to the proper indicating of trains is interesting.

The illustration in Fig. 139 shows the train information office in the train shed of the Caledonian Railway station in Glasgow, Scotland. This office is to the right as one enters the station from the street and in its second story there are 13 windows, one for each of the station tracks. A reasonable time before the train leaves a placard is placed in the proper window, showing at what time the next train will leave from the platform concerned and the stations at which it will stop. It is usually possible to insert the placard about the time the cars are placed whereby the indicating arrangement is made to serve a twofold purpose. Inside the little two-story information office one man works at posting the placards in the windows for arriving and departing trains. The time of incoming trains and the platforms at which they will arrive are shown on a series of boards with painted letters, to the left of the placard windows. There is also a small blackboard below the windows on which is chalked up information about important long-distance trains, such as whether they are on time or a number of minutes late.

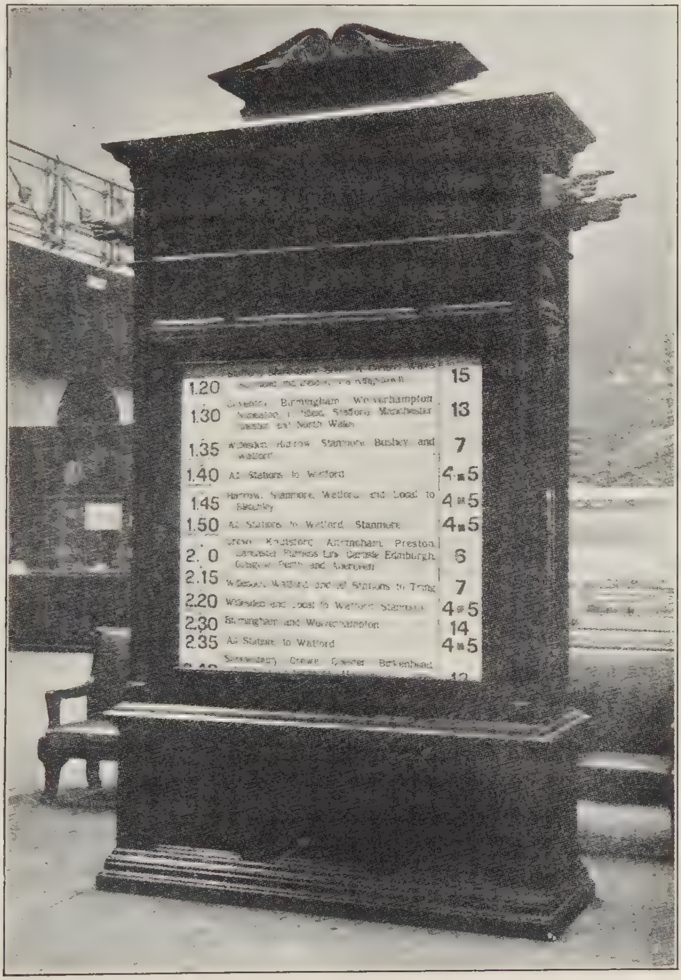
1.20
15
1.30
Birmingham Wolverhampton
North Wales
13
1.35
Stanmore Bushey and Watford
7
1.40
All Stations to Watford
4 & 5
1.45
Harrow, Stanmore, Watford and Local to Bletchley
4 & 5
1.50
All Stations to Watford Stanmore
4 & 5
2. 0
Crewe Knutsford Altrincham Preston
Edinburgh
6
2.15
Watford and all Stations to Tring
7
2.20
Local to Watford Stanmore
4 & 5
2.30
Birmingham and Wolverhampton
14
2.35
All Stations to Watford
4 & 5
Crewe Chester Birkenhead

FIG. 140.—Indicators used by London & North Western.

The bulletin at the Charing Cross Station of the South Eastern & Chatham in London is immediately above the gate leading from the ticket offices to the train shed where it can be easily seen by all outgoing passengers. In this indicator there are two cloth curtains exactly alike. These show the next 15 or 18 trains, their departing time, the principal stops and the track number. When the trains shown on the left-hand curtain have left, that curtain may be rolled up to show those trains then indicated on the right-hand roller, and the latter may be turned forward to show eight or ten new trains.

The indicators at the Euston Station of the London & North Western in London are somewhat similar, the exception being that there is but one roller on each indicator. The indicator cases are placed directly on the floor and in the station there are four of them. Similar indicators are also in use at the stations of the same road in Crewe, Liverpool and Manchester.

Another system is the remote-control scheme which has recently been installed on a number of European railways by the Siemens & Halske Company, Berlin, to indicate to the passengers the character and destination of the incoming and outgoing trains.[1]

These signs usually are hung alongside the proper track. The words "Richtung" ("direction") and "Zug" ("train") are painted on the body of the sign, but the destinations are painted on metal sheets which are arranged to hang from the container as desired. The symbols "P," "S" and "E," corresponding to the abbreviations for the different classes of trains, and the expression "Zuschlagpflichtig" ("extra fare") are also painted on the container. These latter indications are covered by drop shields so that the sign operator exposes only those which relate to the next train. The selective device or sender, which is installed in the dispatcher's office, can be designed to operate any number of signs to give indications of the character described. This selector has two dials, one of which is set for the track number and class of train and the other for the destination. The turning of an indicator to a given figure sends a corresponding number of impulses through magnets, relays and a 110-volt motor in each container, whereby a worm gear is made to move through certain distances to engage with dogs and other selective devices. It is reported that the signs installed at Budapest, Hungary, are operated as often as 140 times a day.

A scheme, by which the name of the station being approached by a train is automatically displayed at the front end inside of each coach, is being prepared. Its failure to operate regularly and accurately would produce obviously interesting results.

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[1] Electric Railway Journal, Jan. 6, 1912.

CHAPTER XIII

BAGGAGE HANDLING AND THE PARCEL ROOM

In England, France, Germany and various other European countries baggage is not handled as it is here. Some of it is checked, to be sure, but usually the passenger is called upon to keep a closer watch upon his belongings than the checking system makes necessary. In London, for instance, cab fares are one shilling (24 cents) for the first two miles, or fraction thereof, with two pence (four cents) for each piece of baggage so that the traveler with baggage drives to—or from—the station and keeps his baggage with him. At the station the large pieces are labeled with the name of the destination station and placed in one of several baggage compartments in the train. On reaching his destination, the owner claims his baggage on the platform where he finds it and the porter, always at hand, calls a cab and loads the baggage on it.

This system, if such it may be called, makes it necessary for the traveler to claim his baggage promptly on arriving at his destination or else run the risk of having it claimed by thieves who are on the watch for such opportunities. Moreover, he cannot readily stop off after he has begun his journey. As against that, he is saved the annoyance, delay and expense which American methods impose and there is no accumulation of unclaimed baggage at stations. But, on the other hand, as noted above, baggage may be checked. A person may check trunks in London and receive a slip of paper corresponding to our check. The slip is given to the hotel porter in Liverpool, let us say, who claims the baggage just as is done here. Indeed, if one should so desire the railways will collect baggage at the traveler's residence or hotel, take it to the station in their own wagons, and deliver it again at residence or hotel at destination, for an inclusive charge of one shilling (24 cents) per piece; this avoids risk of loss, but involves some delay.

In several of the countries on the continent the baggage checking service is not free, with the result that passengers are accustomed to carry far more luggage in the cars than is the rule in this country. The checking system used on some of the railway systems there involves the use of books of labels numbered consecutively in triplicate. One is given to the patron as a receipt, one is pasted on the trunk and the third, or stub, remains in the book as a record.

In the United States the check system is used. The fare paid by the passenger is payment not only for his own transportation but also for the transportation of his baggage, there being a limit on the amount of baggage he can check without excess payment of 150 lb. on a full ticket and 75 lb. on a half ticket. This system with its attendant privileges is a growth of many years. To alter it in any but the most minor particulars would be almost revolutionary. Statistics show that approximately one passenger in ten avails himself of his right to check baggage. The railroads, however, do not find it any small problem to transport the trunks and suitcases checked by even this relatively small proportion of all their patrons. At some periods of the year, indeed, such as that immediately preceding July 4 or that directly following Labor Day it is necessary, owing to the heavy passenger traffic, to provide not only extra equipment on the regular trains but also in some cases entire special trains.

Practically the only revenue from this service in addition to that paid for regular passenger transportation is that comparatively small revenue from the carriage of pieces of baggage weighing over 150 lb. or of value greater than $100. It is thus evident that from one point of view the railroads perform this service at a loss. It is likewise evident that there is a peculiar form of discrimination in favor of that one-tenth which has baggage to check. It has been proposed, therefore, to make a slight extra charge for the carrying of baggage but primarily because of the long-standing practice of the railroads in furnishing this service free of charge and partly because numerous public service commissions and legislative bodies have expressed the opinion that it is incumbent on the transportation companies to furnish the service as part of the contract price of transporting the

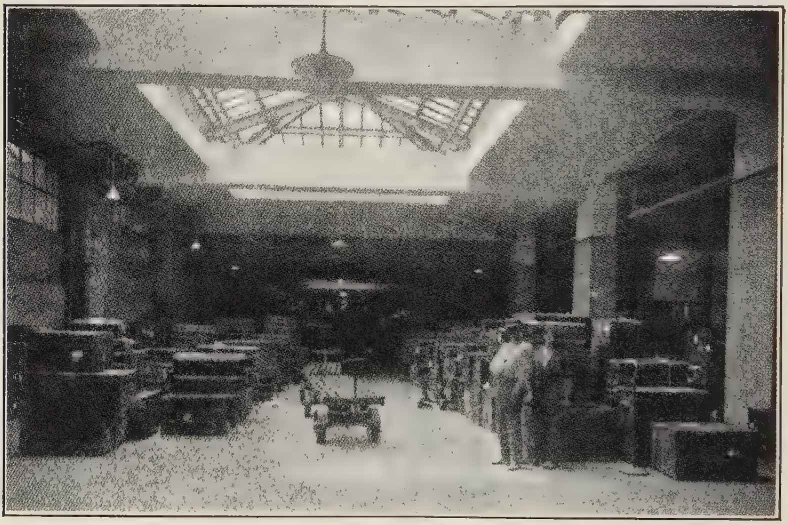

FIG. 141.—Baggage room, Grand Central Terminal, New York.

passenger, the idea has not attained great headway. It might also be argued that if the extra charge were made as suggested less baggage would be checked and that it would be carried instead in coaches or parlor and sleeping cars with a resulting inconvenience for everybody concerned for which the increased revenue on that part of the baggage which was checked would not compensate.

At any rate, the American passenger who has baggage to check at any fair-sized passenger station will usually find a baggage-checking counter in some convenient corner of the station for that purpose. Before an article is checked the passenger's title to transportation, his ticket, must be presented so that the baggage agent may punch it—usually with the letters "BC"—to prevent its being misused. The passenger is then called upon to fill out a declaration of value according to the Cummins Law and as soon as it is ascertained that the article or articles to be checked are not subject to extra charges for excess weight or value and the article is accepted for transportation the passenger is presented with a receipt in the form of a check. In some cases, and particularly on local journeys, a brass check is used, the check containing a number corresponding to that on a similar check attached by a strap to the trunk or bag. In other cases, as on long-distance journeys over more than one road and often also on local trips, the "strap-check" is not used but it is customary to use, instead, the familiar "card-check." This is a small piece of cardboard arranged in two or more sections, separated, the one from the other, by a perforated line, each section containing the same serial number. The various checks used by the different railroads vary greatly. They always show the originating and destination points although in some cases one or the other of these may have to be written in in ink. Often, also, the route is indicated. Some railroads use checks upon which, in addition, are indicated by writing or by punching in the proper square, the kind of article checked, and its condition, particular attention being paid to broken locks, stove in corners, split sides and such defects. Part of the check is torn off on the perforated line and given to the passenger for presentation at the destination point; part is attached to the article checked by a strap or string and if there are three sections, as in the case of an excess baggage check, the third section is kept as part of the record for the auditor's office.

The baggage checked is next turned over to the baggage room proper, there being a chute or elevator provided for that purpose if necessary. In that room it is placed with other parcels for the same destination or at least with other pieces for points reached by the same train. The time occupied from the checking of the baggage by the passenger until its despatch on the train is, of course, determined largely by the size of the terminal through which it passes. From 20 minutes to one-half hour is usually required at terminals in large cities such as New York, Chicago, Philadelphia and Boston.

A similar operation is carried out at small stations, the difference being that there is usually no baggage-checking counter and that the time required for handling from the passenger to the train is considerably less.

In any instance, a careful record is taken of any piece of baggage checked and in this record is included the time the parcel is received and despatched.

At the destination point the baggage will be delivered in most cases within a few minutes after the arrival of the train which brought the passenger himself, delivery being effected, of course, upon the presentation and surrender of the duplicate portion of that check attached to the article. Baggage cannot, in every case, be despatched on the same train as the passenger, although this is done whenever possible. Many trains do not have baggage cars; others already have a full quota of baggage, mail and express and many times passengers do not allow sufficient time for their baggage to be checked and transmitted to their trains although they, themselves, can board them in time. Nevertheless, the percentage of missed connections and the number of times patrons are left without baggage are very small.

Each of the larger terminal stations is provided with a separate entrance for vehicles handling heavy baggage, such as trunks, baskets and other receptacles which passengers cannot or do not care to carry. Most of the baggage delivered at these entrances is from transfer or express companies which have previously contracted with the passenger to make such delivery. These pieces already bear checks similar to those described above but which must be exchanged for checks issued to a specified destination which exchange is made on presentation of the passenger's ticket. To facilitate the movement further and to lessen the inconvenience to passengers transfer companies in all the large cities of the country are authorized to check through from residences, hotels, places of business and other railroad stations and steamship wharves to the destination of passengers as indicated by their tickets. Checks issued by the transportation companies are furnished to the transfer agents for this purpose. The transportation companies have also established in conjunction with transfer and express companies what is known as the "Special Delivery Service." Certain authorized agents in every large city will undertake for a reasonable amount to call for baggage, deliver it to the railroad station designated, and by means of similar arrangements in the city to which the passenger is going, the baggage will be delivered to the proper place without further attention on the part of the passenger. For the little effort involved in the use of a telephone this system not only results in minimum effort on the part of the traveler, but also insures the handling of his property with the least possible delay. This service is also available at many of the stations along the line, so that trunks and other baggage may be delivered at a station by personal cab, carriage or truck and checked through to a residence or place of business in a distant city, the size of which is sufficient to warrant the services of a transfer company.

The tremendous increase in the past few years in the number of theatrical acts and plays traveling from town to town, has made it necessary for carriers to provide extra facilities for the handling of this property. At some of the recently constructed larger stations, special tracks are provided for loading and unloading this kind of material. The properties require quick loading and speedy movement over the line as the close of the performance in one city is frequently the signal for a quick move, oftentimes over night, to another city. This is accomplished without deranging regular service as most of the movements of properties are made during early morning hours, when additional equipment as necessary can easily be provided. These properties are not classed as baggage and are handled solely for the reason that there is required a quick movement which cannot be secured in any other way. The charges made are sufficient to cover the cost of handling and to give a reasonable return to transportation companies as profit. Included under the head of properties are live stock of various kinds for show purposes, performing animals of all sorts, furniture, scenery, and in fact, everything required for the production of plays, vaudeville acts, concerts, etc.

The ever increasing weight and size of baggage has made it necessary for the transportation companies to impose restrictions from time to time for their own protection. One of the first restrictions made was that imposing a limitation of 250 lb. as the maximum weight of any single piece which would be handled. The theory was that this was about all one man could handle without injury to himself or the property, it being remembered that often, as in baggage cars, baggage must be handled by but one employee.

A restriction of comparatively recent origin is the limitation of any dimension to 45 in. A small charge is assessed for each inch in excess of this maximum, the theory being that this will bring the size of most baggage within reasonable limits. This restriction was primarily brought about by the extensive use by traveling salesmen and the public of the wardrobe trunk. The dimensions of this class of baggage reached such proportions that it became practically impossible to pile or stack the trunks, especially in cars, the dimensions of which had already reached their maximum.

The tendency toward the construction of large terminals has in a measure tended to retard the speedy movement of baggage and especially between large cities such as New York and Boston. The greater distances which baggage must necessarily be handled from the places designated as the receiving doors to the train platforms and cars has brought into use electric storage battery trucks.[1] These are now quite generally in use at large terminals throughout the country and have become practically indispensable. They carry greater loads, have greater speed and in consequence are far more economical than the old style hand truck. The latter, however, are in use at all small stations where the haul is short, and there is but little baggage to be handled. Gravity chutes are quite generally in use at stations where the forwarding and receiving plants are not located on the same level. They are principally used for hand baggage.

For a great many years it was the custom to hold baggage for passengers without charge until such time as they found it convenient to call. In more recent years, however, the heavier passenger traffic has eventually made it necessary to treat the problem in another way. Now it is the rule to exact a small charge for storage after a 24-hour free period, on a sliding scale, the charge for the second 24 hours being less than that for each succeeding period of the same duration. The theory is that this charge will relieve congested conditions and the remedy has thus far proved successful.

The parcel room has it in common with the baggage room that both check and handle, as part of their work, articles of baggage. The two facilities are different in that the parcel room by the nature of things can handle only the smaller articles such as suitcases and bags and that the thing checked in it is not removed to be taken to another place but is kept until it is returned to the owner on presentation of the identifying check. In the early days it was customary, as has been noted above, for the railway to care for the bags and trunks of its patrons free of charge. Abuse of the privilege and dispute as to the responsibility for loss or theft made it necessary in the course of time to make special provision leading to the carrier's protection. The service is now performed at all important stations at a small charge and the railways have found not only that their space is being better utilized but that the revenue derived is appreciable. The charge made is nominal, being usually 5 cents for 24 hours although at some large terminals the rate is 10 cents. At many places the parcel room privilege is granted as a concession, the railroad receiving not the charges paid for checking but a yearly rental for the space or a proportion of the profits.

Some of the factors that must be considered in designing and operating a parcel check room are these: The best utilization of the space available; the shape, kind and dimension of the racks or shelves; the proper organiza-

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[1] A full description of these trucks and detailed results of their operation will be found on page 341 of "Freight Terminals and Trains" under "Mechanical Freight Handling."

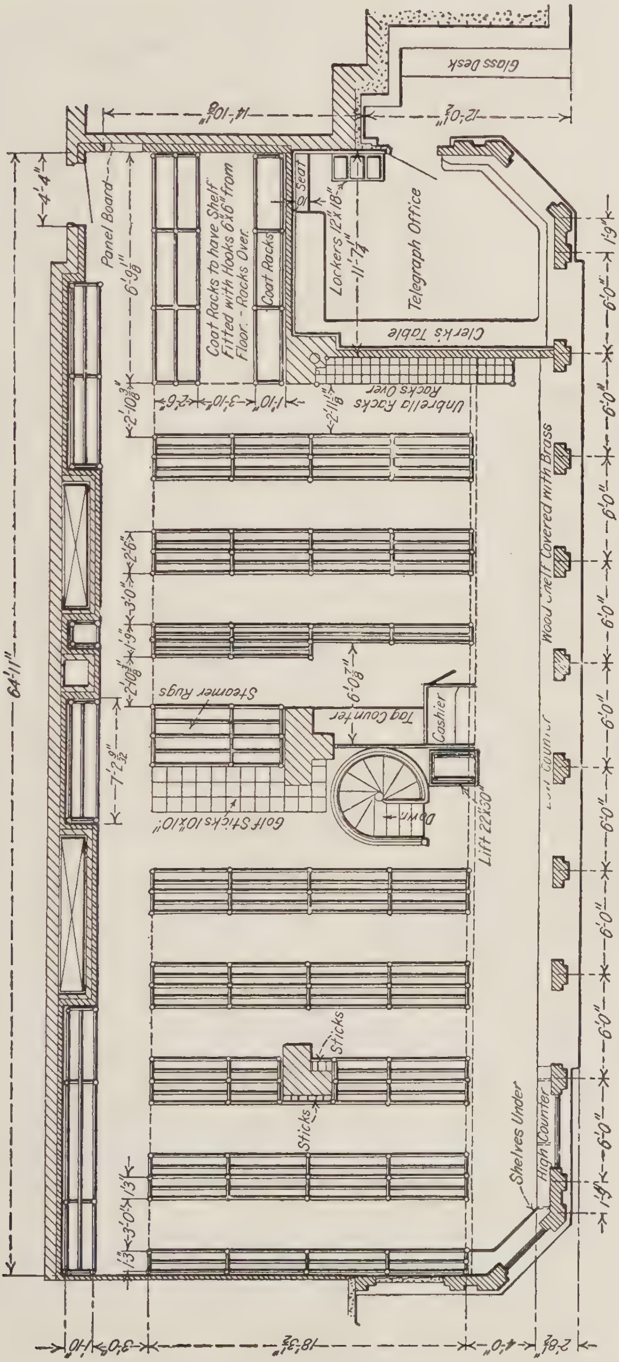

Fig. 142.—General plan of typical parcel room.

tion of the force of attendants; the best methods for the quick storing of packages of various kinds, and the best methods for finding these packages when they are called for, special care being taken that there be no congestion at those moments of the day when several trains leave at about the same time.

The reader will perhaps realize the importance of this part of a station's work better if a few figures are given.

At the South Station, Boston, the floor area of the parcel room is about 3,456 sq. ft. The racks have a capacity of 1,680 pieces. There are eight employees and the room is open all the time. During the past few years this parcel room has handled pieces with receipts as follows:

1906	479,898 pieces	$28,075.95
1907	525,064 pieces	28,950.90
1908	519,525 pieces	29,048.34
1909	585,460 pieces	33,090.40
1910	603,114 pieces	34,808.30
1911	635,047 pieces	36,355.55
1912	679,763 pieces	....
1913	711,280 pieces	....
1914	641,222 pieces	....
1915	525,035 pieces	....

The greatest number of pieces handled in any one day was 4,700, on December 23, 1911.

The plans in Figs. 142 and 143 show the parcel rooms at another large terminal and the details of the racks for packages, coats, umbrellas and golf sticks. The area of one of the rooms is 1,550 sq. ft. but there is in addition a storage room underneath having an area of 1,000 sq. ft. The number of parcels checked in this room aggregates over 25,000 a month.

The methods of checking the parcels presented vary with almost every parcel room. The scheme in use at one important station is as follows: When an article is presented, a check is issued. This check is originally in two sections. The string portion is stamped by a time clock indicating the date and time of receipt and then attached to the article. The other portion is likewise stamped, punched in the proper space to indicate the character of the parcel and then handed to the passenger. The punch also gives an indication of the person who issued the check. The rate charge is 10 cents for 24 hours, an additional charge of like amount being added for each additional 24 hours until the amount reaches $1.00, which carries the parcel for one month. The charge is repeated for the second month. An allowance, as with baggage storage charges, is made for holidays and Sundays. Umbrellas and coats are kept in the racks in separate receptacles. All other articles are piled on the racks or shelves in numerical order using the last two numerals. Thus articles having checks attached ending in 10, 11 or 12 are piled together and those with checks ending in 20, 21 or 22 are piled together, the first in the assignment for the figure 1 and the second in the lot in the assignment for the figure 2. This system is believed to be preferable to using the last numeral, because if the passenger has two or more pieces they are likely to be piled next to one another. This parcel room has eight attendants and its monthly revenues approximate $2,500.

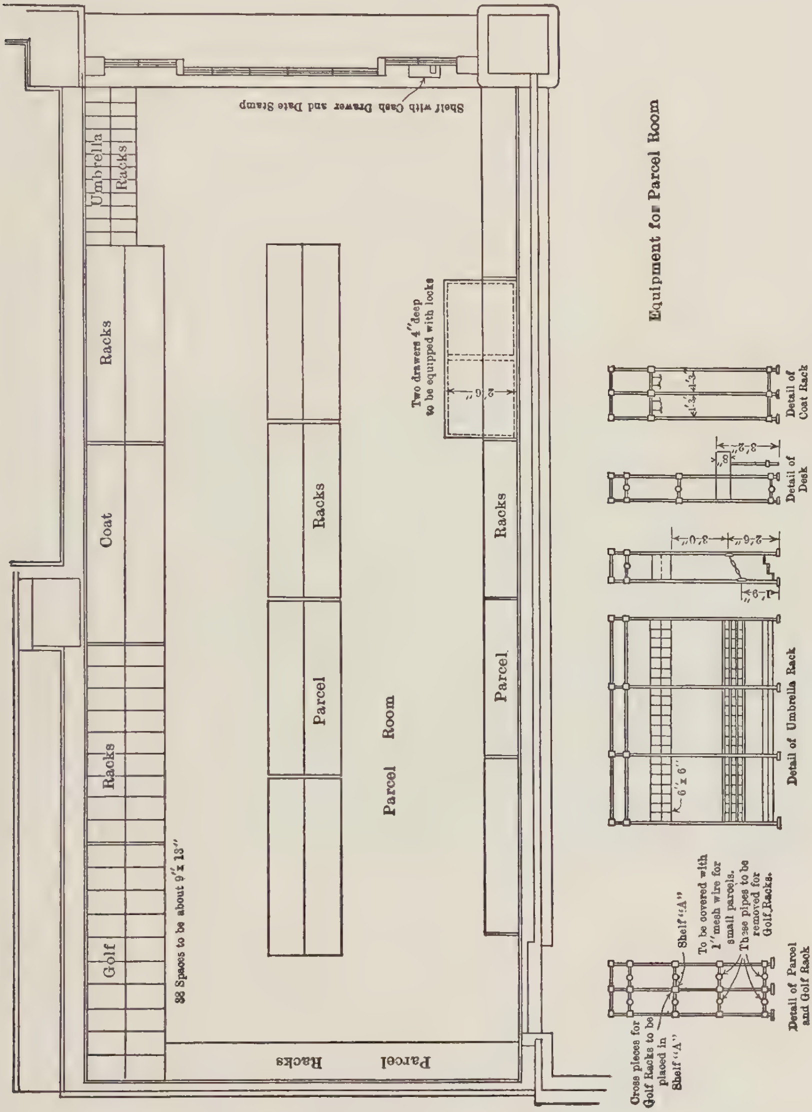
Shelf with Cash Drawer and Date Stamp
Umbrella Racks
Coat Racks
Golf Racks
38 Spaces to be about 9" x 13"
Parcel Racks
Racks
Parcel
Parcel Room
Two drawers 4" deep to be equipped with locks
2'6"
Parcel Racks
Equipment for Parcel Room
Detail of Coat Rack
Detail of Desk
8'2"
3'0"
2'6"
1'9"
Detail of Umbrella Rack
6' x 6'
Shelf "A"
To be covered with 1" mesh wire for small parcels.
These pipes to be removed for Golf Racks.
Detail of Parcel and Golf Rack
Cross pieces for Golf Racks to be placed in Shelf "A"

FIG. 143.—Plan of parcel racks in busy parcel room.

The parcel room often has as part of its work the returning of lost articles.

At the Pennsylvania Station in New York City, for example, 3,630 lost articles were turned in between Nov. 27, 1910, when the station was opened, and July 12, 1911, the most valuable being a pocketbook containing $144, which was immediately claimed by its owner. About 90 per cent. of the parcels received are called for. When they are brought in they are registered in a book, a duplicate ticket is given to the finder, and a tag bearing the same form and number is attached. If, at the end of 90 days, the owner has not appeared, they are returned to the finder. Perishable goods are given to the finder after 12 hours.

Automatic coin-controlled parcel checking lockers have recently been installed by the Chicago & North Western and various other railroads in the waiting rooms of some of their passenger stations, which enable patrons to check their own baggage without the necessity of having a parcel checking room at all. The cabinets used for this purpose are constructed of steel and are built in batteries of 4, 8, 12 or 16 lockers.

A patron desiring to check his bag, selects a vacant locker, as indicated by the fact that the key is in the lock, opens the door, places the baggage inside and closes the door. He then drops a dime in the slot, which releases the key, turns the key to the right and withdraws it. The key is his check and is numbered to correspond with the locker compartment occupied. There are no duplicate keys. To withdraw parcels the key is inserted and turned to the left, and the door is opened. The unlocking of the door automatically locks the key so that it may not be withdrawn again until a dime is deposited.

The interior of each locker is 16½ in. by 12½ in. by 28½ in., large enough to hold a large size suit case. The cabinets are attractive, clean, sanitary, and substantially proof against fire, water or burglary. The advantage to the railway is that it is not obliged to maintain a parcel room and attendant. The advantage to the patrons arises because there are no delays and no necessity for standing in line. There is no possibility of mixing or misplacing articles.

CHAPTER XIV

CAR-CLEANING PLANTS

The exacting nature of the larger proportion of a carrier's patrons and the actual necessities of conforming with the hygienic and sanitary requirements of a rapidly advancing civilization, to say nothing of the preservation of a railway's high class costly equipment, demand that the most thorough facilities be provided for cleaning and airing passenger cars. In view of the relatively low remuneration[1] for the passenger service, it is necessary, in addition, that the work be economically done and provision made accordingly.

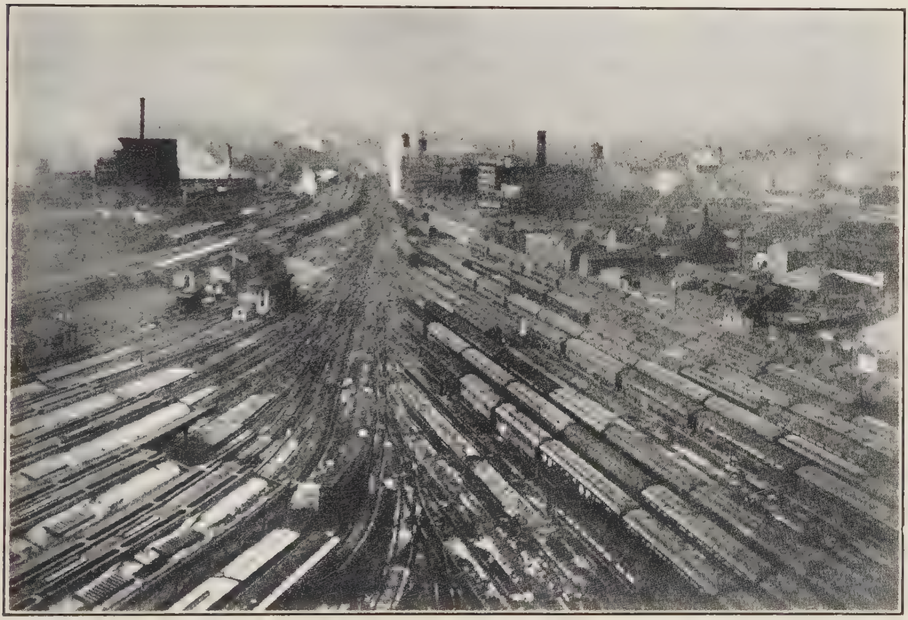

FIG. 144.—View of approaches to Michigan Central Station, Detroit, showing coach yards on right.

A car shed or car-cleaning plant requires good lighting and a convenient, ample and cheap water supply. It must cover sufficient area so that there may be plenty of space between the tracks and on all sides of the cars to be worked on. Facilities are also usually provided for storing and cleaning interior supplies and fixtures such as seat cushions, carpets, etc.

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[1] Believed by many students of railway transportation to be conducted at a loss oftener than at a profit. See Chap. I.

The tendency in car construction in recent years has been to make the interiors comparatively simple in design and to avoid wherever possible nooks and crannies wherein dust or cinders may lodge. The use of suction or vacuum cleaning apparatus has also gone a long way toward simplifying and cheapening the cleaning process.

Coach yards, as compared with freight yards must provide for more precise and exact movements. In them incoming trains are received and their cars stored and cared for during the layover or, rather, until they are arranged preparatory to being taken for outgoing trains. The work of the yard is somewhat complicated by the necessity of arranging coaches of various classes, and mail, baggage, express, dining, chair and sleeping cars in a certain inflexible order. As opposed to the freight yard where cars may be loaded before being assembled into trains, passenger trains must be made up and ready to start before receiving their loads.

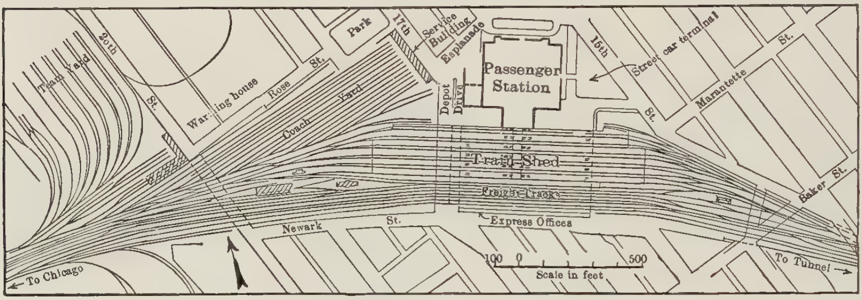

Fig. 145.—General plan of Michigan Central Station, Detroit, showing location of coach yards.

When passenger trains have been emptied and drawn either by the road engine or by a yard engine into the make-up yard, mail and express cars must be separated from the others and taken to the place provided for them. Then the remaining cars must be arranged in the way in which they are to go out with the next train; then they must be cleaned, charged with gas and provided with supplies. To facilitate this work each make-up yard should have the following tracks and accessories:

1. Ladder tracks to provide for trains leaving the station platform for the yard and arriving from the yard.
2. Classification tracks for separating and remaking trains.
3. Car sheds with the necessary tracks to reach them.
4. Make-up tracks for through trains and for dining and sleeping cars.
5. Storage tracks holding ordinary coaches for fluctuating traffic.
6. Tracks for the storage of set-out and additional cars.

The designer of a passenger coach yard[1] must aim to obtain the highest efficiency without diminishing safety; specifically, he must provide for ready enlargement in the case of increased traffic, and study out the best possible arrangement of the connections between the yard and the station platform. At large stations this connection requires several tracks and it is often a source of trouble, especially where there is dense traffic, to have the main tracks serve as part of the communication between the yard and the station platforms, although this is in many cases unavoidable. It is essential not only that all parts of a yard be so built as to avoid superfluous movements, but also that they be arranged in such a way that no operation is likely to disturb another one. If several switch engines have to work in one yard, independent groups of tracks should be provided for each.

So far as design is concerned, it cannot be too strongly emphasized that a uniform and coherent arrangement is more important for a coach yard than for other yards or stations. It is not sufficient to reserve a certain space against the contingency of future enlargement, but this enlargement should be designed and provided for when the yard is first built. In case a yard is not sufficient for the traffic, it is generally not desirable to add further groups of tracks in order to increase its efficiency, but it will probably be better in most cases to change the whole track arrangement. In determining the number and total length of the tracks in a coach yard it is best to make an imaginary schedule containing the maximum number of trains to be handled at a given station. In no case should it be attempted to reduce the length of yard tracks and build larger platform tracks instead, for platform tracks are always more expensive than yard tracks, and require more space, as the platform must be considered and a certain number of safety devices and constructional arrangements will be necessary, which are apt to cost much more than those of a yard. Moreover, every platform track renders the whole plant more complicated and necessitates especially at terminal stations, an increase in size of the station building. Furthermore, cleanliness and the general condition of the air are greatly impaired if trains have to be cleaned and provided with gas within the station building.

Coach tracks are generally united in a bundle, as this makes supervision easier, and the pipings for gas, steam (for preliminary heating), compressed air and water can be shorter.

A turntable is indispensable in case there is no Y track. Car sheds serve for the protection of the more expensive rolling stock against deterioration by climatic influences when out of commission.

Make-up tracks for Pullman, dining and sleeping cars are desirable, because these trains and cars require special treatment and have therefore to be so placed as not to be affected by the switching of the other cars, in order to facilitate loading provisions, ice, laundry, etc., by persons not employed by the railroad. It is advisable to build these tracks at a place where they may easily be reached from outside the station. A much larger space is required for storage tracks for those cars which are not in commission during the time of slack service, because a considerably greater number of passenger coaches, mail and express cars are

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[1] This is quoted from an article reproduced from the German in the Railroad Gazette of September 8, 1905, pages 235–6.

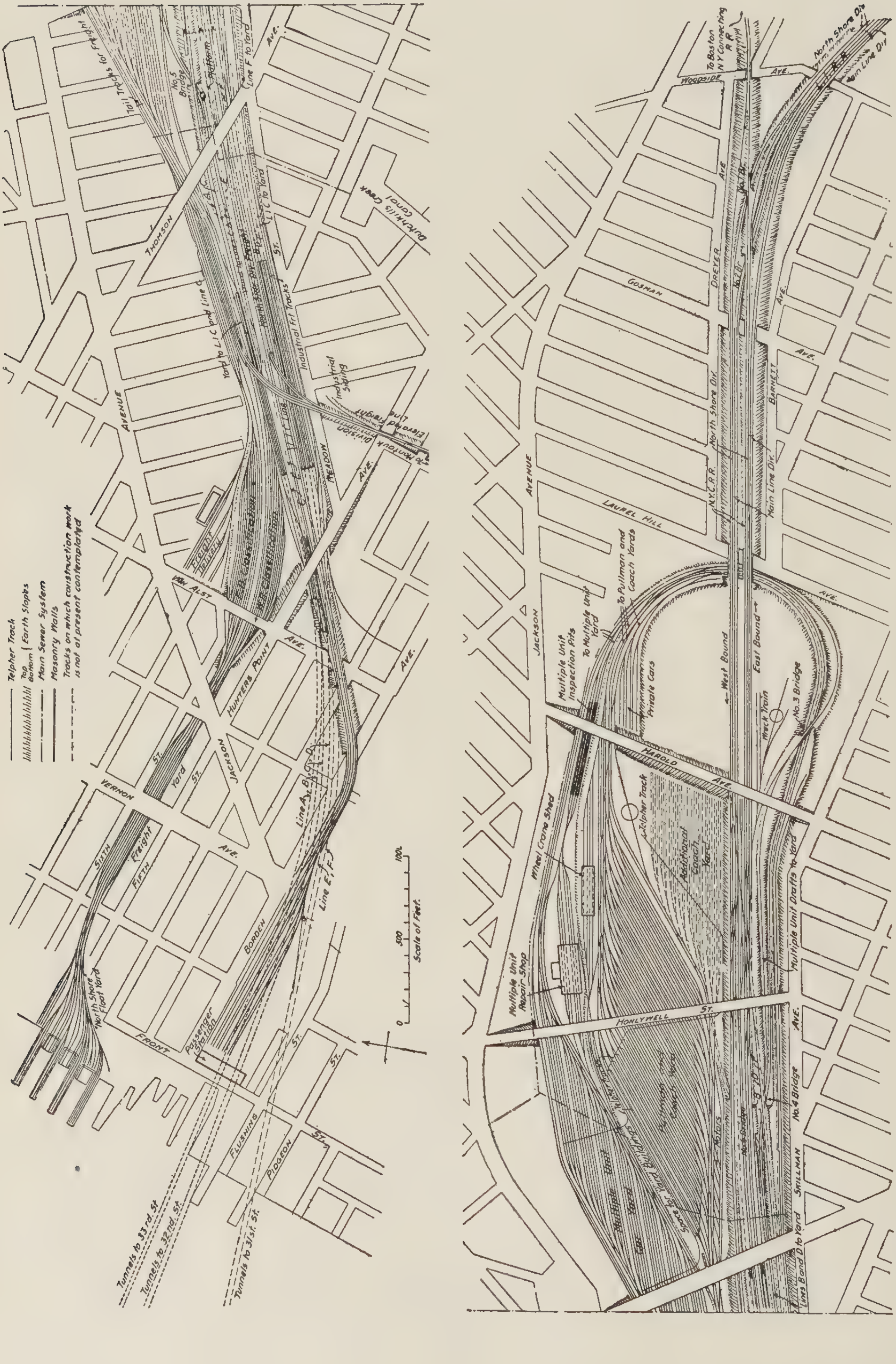

FIG. 146.—Plan of Sunnyside Yard.

attached to a station than are regularly used. Generally speaking, storage tracks for set-out and additional cars have to be near the station platforms, as the latter class especially is often added to the train at the last moment.

As an indication of what is deemed necessary to care for the passenger equipment of a large terminal, a few figures relating to the proposed additions to the St. Louis Union station may be helpful. A plan of the coach storage yards at St. Louis is shown in Fig. 86. In the present plant there is room for 588 coaches and 77 express cars, a total of 665 cars, estimating 80 ft. to each car. Under the proposed plans there will be storage room for 962 coaches and 77 express cars and in addition repair tracks sufficient for 32 cars, a total of 1,071 cars, or 62 per cent. more than at present.

The plan in Fig. 145 showing the layout of the new Michigan Central terminal in Detroit will show the relative location of the station, the coach yard and other accessories in a typical passenger terminal layout.

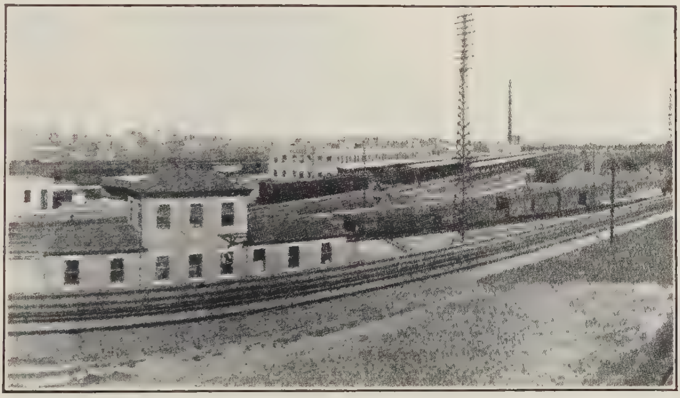

Fig. 147.—Sunnyside Yard.

The plan of the Pennsylvania Railroad's Sunnyside coach and train yard at Long Island City, Fig. 146, was arranged, following the railroad's usual custom, in accordance with the suggestions of a committee representing both the engineering and operating departments. This committee called in other operating men to its conferences and got the word of the man on the ground. It decided the definite location and formulated a track plan from which the detailed drawings were made and preparation for the construction work commenced. The method was briefly referred to in the chapter on "Construction and Maintenance Details." It is unfortunate that many large systems still leave these matters wholly to the engineering department.

The Sunnyside Yard embraces a tract of land about 2 miles long and 1,500 ft. wide. The yard proper is divided into six sections, as follows: two for Pullman cars, capacity 340 cars with an average of 17 to a track; two for coaches, capacity 375 cars, 20 to a track and two for multiple unit cars, 700 cars, 24 to a track.

The yard tracks are so far as possible, continuous, rather than stub end, so that nearly all drafts may be taken around the loop, entering at the east end of the yards and leaving at the west end. This keeps all yard traffic moving in the same general direction, avoiding many conflicting movements and lessening the danger of collision. The whole yard is operated electrically. All crossings of tracks at grade are avoided by the use of track bridges. A freight classification yard, having a capacity of 400 cars, is located just north of and adjacent to the tunnel portals about half a mile from the East river. From here nearly all freight is carried by a Y or switchback along the north side of the passenger yards to an elevated line crossing the passenger tracks and running southward for about half a mile to a junction with the Montauk division. Freight, therefore, does not pass through the Sunnyside Yard.

To determine the necessities, an investigation of the old passenger yard facilities at both Jersey City and Long Island City was made and the following working information produced. At Jersey City there were two yards: the Waldo Avenue yard, about 1½ miles from the station, and the Jersey City, adjacent to the station.

Waldo Avenue Yard

No. of tracks	27
Capacity of yard	320 cars.
No. of cars per track, varied from	2 to 20 cars.
Max. No. of cars in yard at one time	250 cars.
Max. No. Pullman cars in yard at one time	110 cars.
Max. No. Penn. R. R. cars in yard at one time	140 cars.
Average No. Pullman cars per 24 hours	160 cars.
Average No. Penn. R.R. cars per 24 hours	160 cars.
Maximum No. Pullman cars per 24 hours	210 cars.
Maximum No. Penn. R.R. cars per 24 hours	175 cars.
No. of wheel tracks	2
Time at which maximum number of cars were in yard	9 to 10 A.M.

This yard was used exclusively for through and Pullman business, and no attempt was made to separate the Pullman or dining cars from the coaches. Those in charge of the yard thought this proper and also considered that a track holding 12 cars and one locomotive or about 900 ft. long, was the most suitable length, even though the make-up sheet showed that few trains had more than eight cars.

Jersey City Yard

No. of tracks	13
Capacity of yard	158 cars.
No. cars per track, varied from	4 to 17 cars.
Maximum No. of cars in yard at one time	175 cars.

JERSEY CITY YARD.—(*Continued*)

Maximum No. coaches in yard at one time	115 cars.
Maximum No. express cars in yard at one time	31 cars.
Maximum No. mail cars in yard at one time	30 cars.
Average No. of express cars per 24 hours	40 cars.
Average No. of mail cars per 24 hours	37 cars.
Time at which maximum number of cars were in yard	3 P.M.

This yard was used for local, mail and express service. It was quite congested and to handle the business properly should have had, it was thought, a capacity of 275 cars. The yard master recommended tracks having a capacity of 15 cars and a locomotive, or about 1,050 ft. long, his idea being to handle two trains on one track. It was also thought probable that 65 per cent. of the suburban service to Jersey City would continue to be handled at that point either by the ferry or by the Hudson & Manhattan.

At Long Island City there were three yards.

YARD NO. 1

No. of tracks	20
Total capacity of yard	285 cars.
Capacity of longest track	15 cars.
Capacity of shortest track	8 cars.
Maximum No. of cars in yard at one time	285 cars.
Time at which maximum No. of cars were in yard	11 A.M.

This yard handled the North Side division and through business.

YARD NO. 2

No. of tracks	5
Total capacity of yard	50 cars.
Capacity of longest track	15 cars.
Capacity of shortest track	5 cars.
Maximum No. of cars in yard at one time	50 cars.
Time at which maximum No. of cars were in yard	11 A.M.

This yard handled all the local business excepting the North Side division.

YARD NO. 3

Total capacity of yard	50 cars

This yard was for race trains and was always filled except during racing hours.

During the 24 hours, the maximum number of cars operated out of Long Island City was 556. At 11 A.M. there were 450 cars in the yards, 45 of which necessarily had to stand on the station tracks. Those in charge of these yards recommended tracks having a capacity of 12 cars each.

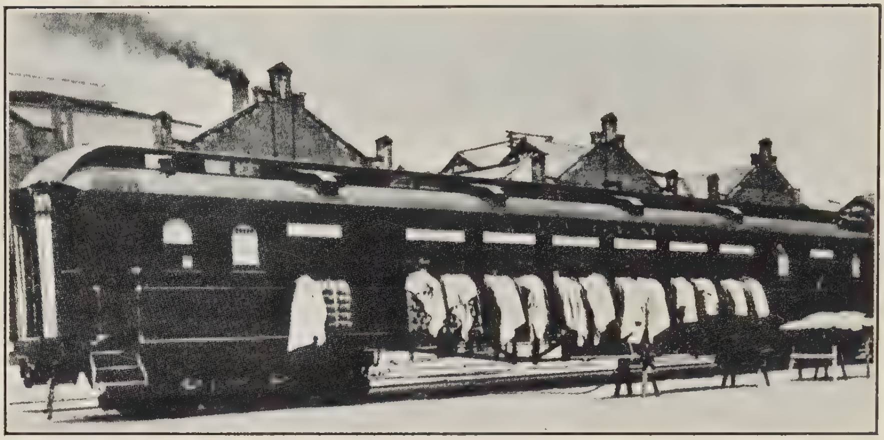

FIG. 148.—Airing bedding of Pullman car.

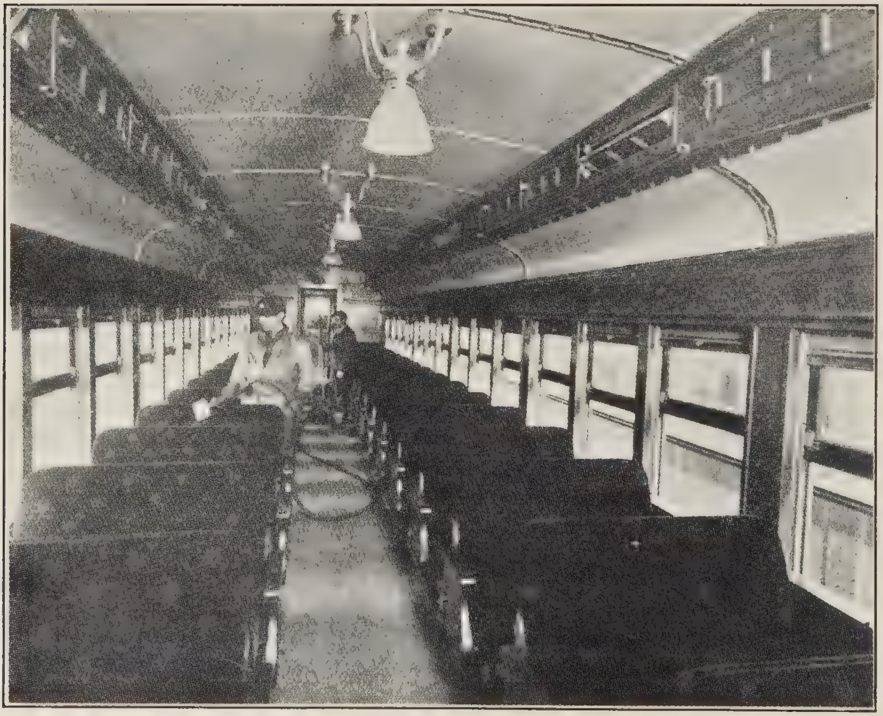

FIG. 149.—Vacuum cleaning coach interior.

Both the Pullman and Pennsylvania yard people agreed that tracks in the through coach yard should be spaced with alternately wide and narrow platforms; that the planking should extend to the rail and level with it; and that the narrow spacing should leave 6 ft. between cars and the wide spacing 15 ft. The wide platforms are covered by a shed with a roof extending over the lower decks of the cars. The tracks are 16 ft. and 25 ft. apart, center to center, respectively. In the local yard a space of 4 ft. between cars, *i.e.*, 14 ft. center to center, of track, was considered ample.

It was the opinion of the yard men that each wheeling track[1] should be long enough to allow five cars to be worked at once and that the tracks should be spaced 25 ft., center to center, and each track have a pit under it. An overhead traveling crane was suggested, together with space for storing wheels and facilities for turning wheels and axles.

It was felt that the coach and Pullman yards should be piped with separate lines for steam, gas and water, and also air for cleaning and for brake testing; and that there should be, also, outlets for charging electric storage batteries. The recommendations were as follows:

Steam: Locate outlets at both ends and middle of all tracks.
Water: Pipe all tracks with 100 ft. between plugs.
Gas: Pipe all tracks with 100 ft. between plugs.
Air for cleaning: Pipe all tracks with 100 ft. between plugs.
Air for testing: Locate outlets at both ends and middle of all tracks.
Battery charging: Wire all tracks with 65 ft. between plugs.

It was suggested that the carpet shed should have platforms 15 ft. by 75 ft., and about 4 ft. above the ground, the vacuum cleaning system being considered preferable to the blower system. The following table shows the floor space at the Waldo Avenue yard, where 700 men and 30 women were employed; also the floor space required to perform the work properly:

PULLMAN STOREROOM SPACE AND REQUIREMENTS

	Present	Required
Heavy material storeroom	800 sq. ft.	1,100 sq. ft.
Miscellaneous storeroom	2,500 sq. ft.	3,800 sq. ft.
Clean linen storeroom	1,500 sq. ft.	2,600 sq. ft.
Soiled linen storeroom	2,000 sq. ft.	4,000 sq. ft.
Cleaners' equipment storeroom	360 sq. ft.	900 sq. ft.
Plumbers' storeroom	360 sq. ft.	900 sq. ft.
Carpenters' storeroom	600 sq. ft.	1,200 sq. ft.
Carpet storeroom	700 sq. ft.	1,100 sq. ft.
Record storeroom	600 sq. ft.	1,200 sq. ft.
Porters' storeroom	750 sq. ft.	1,200 sq. ft.
Commissary storeroom	3,600 sq. ft.	7,200 sq. ft.
Supt. and foreman's office	360 sq. ft.	900 sq. ft.

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[1] A track provided with facilities for applying trucks or wheels to railway cars.

It was decided that if the soiled linen was placed on the second floor, an elevator for raising and a chute for lowering the linen should be provided. It was agreed that ample toilet facilities should be provided throughout the building, the porter's room having separate toilet and bath facilities. The refrigerating boxes in the commissary should be cooled by refrigerator plant rather than by icing.

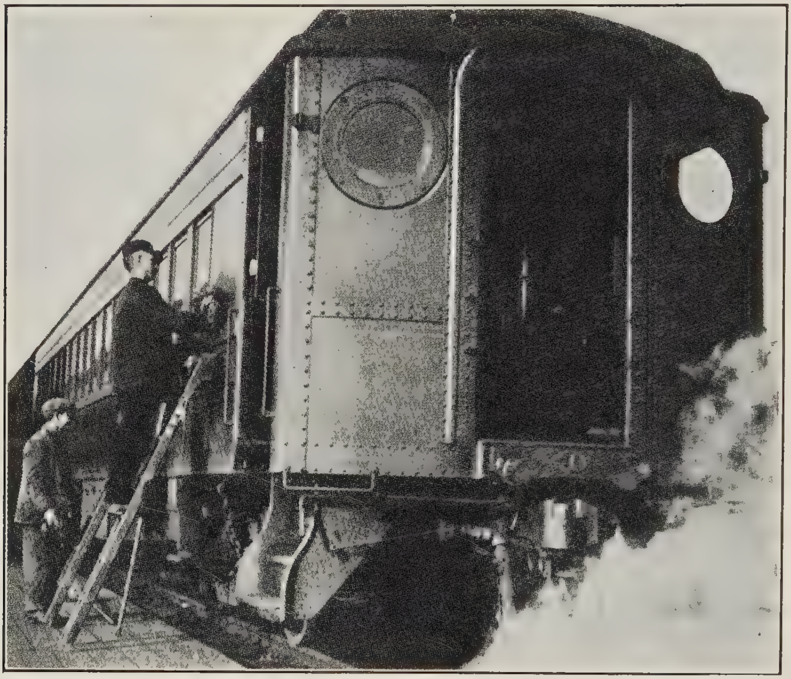

Fig. 150.—Rubbing down exterior of coach.

Pennsylvania Railroad Buildings

	At present	Required
Battery house	1,850 sq. ft.	5,500 sq. ft.
Maintenance-of-way storeroom	8,500 sq. ft.	14,400 sq. ft.
Carpenter shop	1,000 sq. ft.	1,400 sq. ft.
Carpet room	720 sq. ft.	720 sq. ft.
Steamfitters' room	750 sq. ft.	1,500 sq. ft.
Air-brake room	240 sq. ft.	240 sq. ft.
Tinsmiths' room	375 sq. ft.	500 sq. ft.
Officers	600 sq. ft.	1,200 sq. ft.
Yardmasters' office	450 sq. ft.	900 sq. ft.

The following amounts of waste, cleaning and lubricating oils were used per month, and a suitable building, it was felt, should be provided for the storage of the same together with about 300 sq. ft. each for Pennsylvania Railroad and Pullman paints:

	Used monthly		Storage-room required for
Pullman cleanzine	40	bbl.	80 bbl.
Pullman kerosene	30	bbl.	60 bbl.
Pullman cotton waste	16	bales	30 bales
Penn. R.R., cotton waste	5	bales	10 bales
Penn. R.R., woolen waste	1½	bales	3 bales
Penn. R.R., Galena winter oil	40	bbl.	60 bbl.
Penn. R.R., Galena summer oil	40	bbl.	60 bbl.

The general sentiment of all the yard people was opposed to narrow-gage tracks for trucking purposes between the standard gage tracks. It was also agreed that a single post inverted umbrella shed was preferable to any other type.

There were at the time about 150 motor cars and trailers in the Long Island Railroad electric service. The officers in charge of this equipment recommended a spacing of 14 ft. center to center of track for the multiple unit storage yard, or 5½ ft. between cars.

The motor cars were inspected on a mileage basis, cars going over the pits after having run 750 to 800 miles on the road. With the service, this averaged once in four days. The pits now in use have a capacity of four cars each, all light repairs being made while the cars are over the pits.

From the above-mentioned investigation, it was seen that, in order to handle business of an amount equal to that carried at that time, yards had to be provided having a capacity of at least 840 cars, about 500 of which were used in through service. In the course of a very few years, all the local or suburban trains will be made up of multiple unit equipment and consequently were considered as such in the design.

In developing the plans for the Sunnyside yard and contemporary improvements, the following general ideas were kept in mind and the design made to conform thereto: Separation of multiple unit equipment from ordinary coach and Pullman equipment; main tracks separated from the yard proper and the running tracks leading thereto, by being placed on a different level; no crossing of running tracks at grade; all switches designed so as to allow as many parallel movements as possible without unduly complicating the track situation or greatly increasing the cost; running tracks and connections between the main tracks and yards arranged so as to allow an alternative route for each movement, these alternative routes being widely separated so as to prevent the yards from being tied up by a serious derailment or wreck occurring at any particular point.

The coach and Pullman storage yard consists of 11 tracks, spaced alternately 25 ft. and 16 ft., center to center, and 35 tracks divided into groups of six tracks each with a spacing of 14 ft., center to center, between the tracks of each group and 19 ft. between groups; these tracks vary in length from 950 to 1,100 ft. of clear standing room and have a total capacity of 600 cars. The southerly or leaving ends of these tracks are connected to a three-track ladder, the far track of which serves to connect with a small storage space for electric locomotives or motors. The northerly or entering ends of these tracks are connected with a ladder increasing from one to five tracks as the number of storage tracks connected thereto increases. While the general design of the Sunnyside Yards is such that much switching of cars will be avoided, yet it has been thought best to provide the above-mentioned five-ladder tracks with connections which will let a considerable number of switching movements be made without interfering with the movement of drafts entering the yard. It was the intention to equip at least one track in each group with inspection pits. With a track spacing of 14 ft., center to center (15 ft. where column foundations for viaducts are introduced) it will be noted that by removing each third track and lining over each second one of the remaining two, a spacing of 26 ft. and 16 ft. may be obtained, thus affording a ready means of increasing the number of wide-spaced tracks should traffic conditions require it. A yard for private cars, with a turntable, has been provided as shown on the plan.

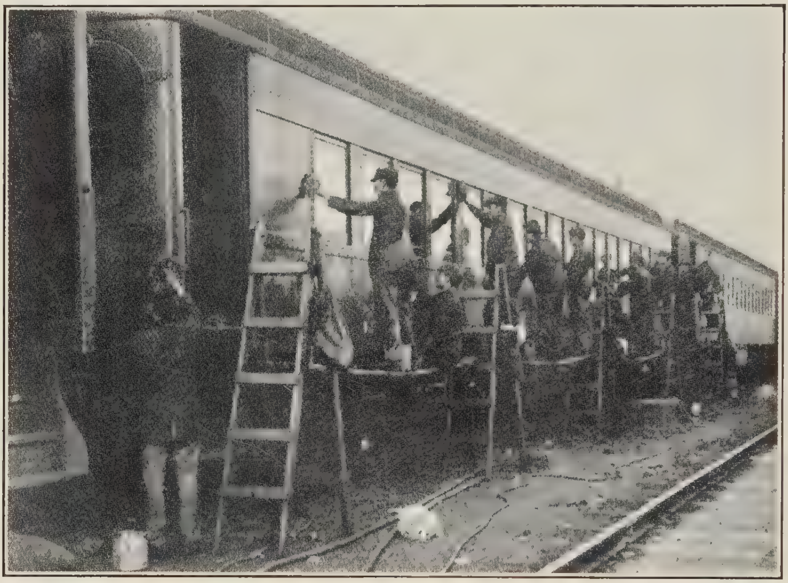

FIG. 151.—Cleaning exterior of coach.

A portion of the space within the loop has been utilized in the design for an additional storage yard, having stub end tracks with a total capacity of 350 cars. The construction of this yard is not contemplated for some years. Throughout the yards, all ladders and running tracks have been spaced 13 ft., center to center, and all connections have been designed for No. 8 frogs except at the loop switching plant, where a few No. 10's and No. 12's were found necessary.

It is a mistaken idea that money is saved by permitting a passenger car to run long enough to become so dirty on the outside that hard rubbing and much time and labor must be expended to make it clean. It is far better to take the car while the dirt may be removed easily and the varnish left bright. Scrubbing and rubbing with any kind of grit leaves the varnish dull, shortens its life and is costly in so far as the labor and time equipment is kept out of service are concerned.

Hand rails, truss rods, etc., should be wiped clean and dry. Cleaning trucks does not accomplish much, and, at any rate, they will not remain clean long.

Wiping the varnish work of a car's interior with a damp cloth, care being taken to gather and not scatter the dust, will keep it clean for a while, but it is preferable to sweep the floor and dust the car first. Even then it may occasionally be necessary to clean the car with soap and water. Pumice or other grit, however, should not be used.

If the polished portions of the interiors of sleeping and chair cars can be cleaned with weak soap and water and dried with a chamois or soft cloth, it will be better than to use oils or oily fluids which afterward retain the dust. If the polished portions become very dirty, good results may be obtained by the use of a mixture of crude oil and alcohol applied with cotton waste or a soft cloth and wiped dry with a soft cloth dampened with alcohol. The work should be done by experienced mechanics, however, and not by ordinary laborers as this mixture must be used with extreme care. A soft bristle brush and weak soap suds are good for attacking headlinings, the flat portions being sponged and rinsed and dried with a chamois. Vacuum cleaning machines are the cheapest and best for cleaning chairs and cushions and probably do not injure good plush. Round window glass may be effectively cleaned with a minimum of breakage by wiping with dry waste, inside and out, and occasionally cleaning well with tripoli and water. Gothic lights, cathedral, opalescent and other kinds of glass may be quickly cleaned by applying muriatic acid and sponging with clean water, but a careful man must be assigned to the task.

The Pullman Company is noted for the care it takes of its chair and sleeping cars. Formerly, the company used compressed air for the greater part of its cleaning, but within the last two years, as a result of careful experiments, it has adopted vacuum cleaning apparatus. This it finds both cheaper and more convenient. When compressed air was used, it was necessary, because of the wide distribution of the dislodged dust, to clean the carpets, cushions and bedding in the open air. The variability of weather conditions in most parts of the United States is such that it was frequently hard to follow fixed schedules of cleaning, it being inadvisable to expose the cushions and bedding in damp or stormy weather. By using vacuum cleaners, the work can be done inside the car and schedules are more easily maintained. One of the chief drawbacks to the use of vacuum apparatus has been the difficulty of dislodging accumulations of dust from between the window panes, from behind steam pipes and from the nooks and corners about the deck lights. This difficulty has been overcome by the use of vacuum machines which can be converted into blowers. In cleaning a car, the dust is first dislodged by blowing and then the current is reversed and the carpets, etc., are gone over with vacuum nozzles in the regular way.

Pullman employees are very carefully instructed in the principles of cleanliness and sanitation and are subjected to strict discipline in these matters.[1] In the sanitary regulations for the instruction and guidance of employees issued by the company's superintendent of sanitation, employees are especially prohibited from dry sweeping the interior of the car in transit with an ordinary broom, from dry dusting the interior of cars, and from brushing passengers' clothing in the body of the car. They may wipe uncarpeted floors with a wet sponge, cloth or mop, but they are carefully instructed to moisten with disinfectant any place where spit, vomit or other discharges are found. The most important element about the rules is, incidentally, that in every case the reason why is given.

As it is well known that the Pullman Company has taken greater pains than almost any other organization to keep its equipment pure and free of the germs of disease, it will be interesting to see what methods it follows. Cars are usually fumigated according to a regular monthly, weekly or other schedule, but whenever a person sick with a contagious disease is found in the car, the car must be fumigated as soon as vacated. To secure the time necessary for airing out the car, fumigation precedes the cleaning. Before the fumigaton takes place the car windows, deck sashes and ventilators are closed. Everything is then done to expose all the contents of the car as much as possible. The seats are pulled forward, the upper berths opened, the mattresses in all berths arched up in the middle to expose the under side, the curtains hung with as few folds as possible, the blankets thrown over the curtain rods with the fewest possible folds and the pillows laid out loosely. The temperature of the car during fumigation is at least as high as 70 degrees. The disinfectant, formaldehyde, is generated in a fumigator containing 5 oz. of so-called solidified formaldehyde, dissipated by heat from a paraffin burner. Two of these burners are used, one being placed in a pan of water at each end of the car. The wicks are lighted and the doors tightly closed. The burning continues for about 30 or 40 minutes but the car is left closed for a minimum of three hours after which it is opened, thoroughly aired and cleaned. Such fumes as are left at that time do no harm, it having been found that while the formaldehyde fumes are very irritating to the eyes and throat, they are not dangerous in moderate quantity. Before the war had cut off the supply of that chemical, the company used permanganate of potassium, a half pound of which was put into each of three large galvanized buckets, one each at the ends of and one in the middle of the car. A man then passed through and emptied into each bucket a pint of liquid formaldehyde, immediately leaving and closing the car. By this method the full strength of the fumigating gas was generated in from three to five minutes instead of the 30 or 40 minutes demanded by the present method. It is understood that the sanitation authorities much prefer the older method and expect to return to it as soon as permanganate of potassium again becomes available.

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[1] The writer is indebted to Dr. Thomas R. Crowder, director of the Pullman Company's Department of Sanitation and Surgery for the information given herewith relative to the cleaning and disinfecting of the cars of that company.

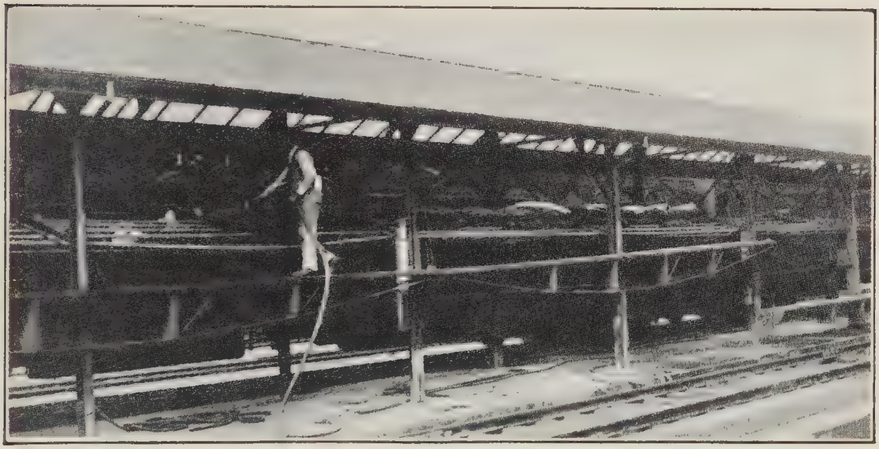


FIG. 152.—Cleaning mattresses of Pullman sleeping car.

Various foreign railway administrations have made investigations and done other work in the way of disinfecting railway cars to rid them of disease germs and insects. One of the methods formerly in use in Germany was especially interesting. Cars used to carry emigrants from the interior of Europe to the north German ports before the war were at times infested with vermin. At one time it was necessary to remove all the upholstered parts and the wainscoting to clean the car thoroughly. This involved loss of time, was expensive and there was danger of vermin escaping into the shops and subsequently infecting other cars. The use of formalin made the disinfection more perfect, but there were no devices by which the formalin vapors could be made to penetrate to any great depth into recesses. A plan was worked out, however, and was in operation just prior to the European conflict, by which the car requiring treatment was pushed into a large cylindrical device, both ends of which would be closed by cast-iron heads. The cylinder was heated by a system of pipes until a temperature of from 114° to 122°F. was obtained in the interior. Air was then pumped out until the pressure was reduced from 27 to 29 in. of mercury below normal and without interrupting the heating process.

Water will boil at this air pressure at a temperature of 104°. Insects and other living organisms are thus deprived of every particle of moisture and must consequently perish. Preliminary experiments, on these lines, indicated that bed bugs could not be destroyed by either heat alone or by the production of a vacuum, but that they could be absolutely destroyed by these two factors in combination. By the process also, vermin and nits could be destroyed without removing or taking apart the car cushions, leather fittings, wooden frames wainscotings, etc., and without damaging the outside varnish or the interior polish.

Formalin was introduced, when the vacuum was at its lowest point, and was quickly evaporated, if the car was to be disinfected according to regulations.

The apparatus was designed on a basis of 3,129 lb. per square inch pressure, and 1,565 lb. per square inch in tensile strain. The total weight including the crane was 297,000 lb. The plant was started in the fall of 1909; its approximate cost was $18,000. The operating expenses for disinfecting a large sleeping or vestibule car were about as follows:

If heated during 10 hours, 1100 lb. of coal and water	$1.90
40 kilowatt-hours electric current for power and lighting	0.95
11 lb. of formalin	1.07
Pushing car in and out of the apparatus including expense of attendance	0.84
Total	$4.76

If 5 per cent. of the invested amount be added for interest and for decrease in value resulting from wear and tear, and presuming that one car per day was treated in the apparatus, the total expenses per car amounted to $8.33. With the old method of cleaning cars infested with vermin, the expense for labor was not only ten times as high, but it was also impossible to be sure that such cars were perfectly and thoroughly cleaned.

CHAPTER XV

SMALL STATIONS

The simplest and least important station of all is known as the "flag" station and derives its name from the fact that the business handled by it is so light that a train will not stop to take passengers unless it has been "flagged" by a hand or lantern signal or to leave them unless notice has been given to the conductor. In turn, the simplest form of flag station is a landing which often consists of nothing more than a gravel or cinder platform from 60 to 100 ft. in length. At more important places there may also be a shelter of some kind. In some cases it is merely a roof and in others a roof with one, two or three walls, the side toward the track being open. Next in the ascending scale is the wholly enclosed building with a door and one or more windows—often a very objectionable arrangement, especially if proper supervision is lacking, because it proves so inviting to tramps and other objectionable characters. A station of this kind requires some attention in order that it be kept clean and also kept warm in winter. A trackman or crossing man is usually impressed for these duties.

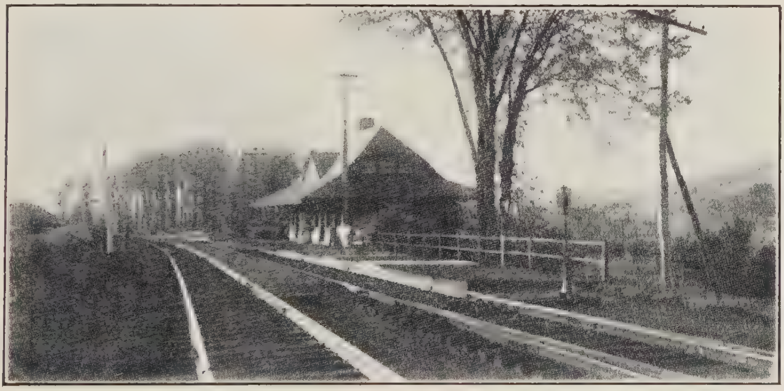


FIG. 153.—Typical Boston & Albany station, Dalton, Mass.

The next step in order is the station whose business is important enough to require the services of an agent and a building containing other facilities than a mere waiting room. The American Railway Engineering Association has recommended a plan for a passenger station of this character, containing besides the waiting room, a women's retiring room, toilets, ticket and telegraph offices and a baggage room. The plan is given in three sizes, as shown in the drawings in Fig. 154. In each case the floor area of each room is given as a percentage of the total and varies with the size of the station. The layout has a number of advantages, including the proper proportioning of the size of the rooms to the size

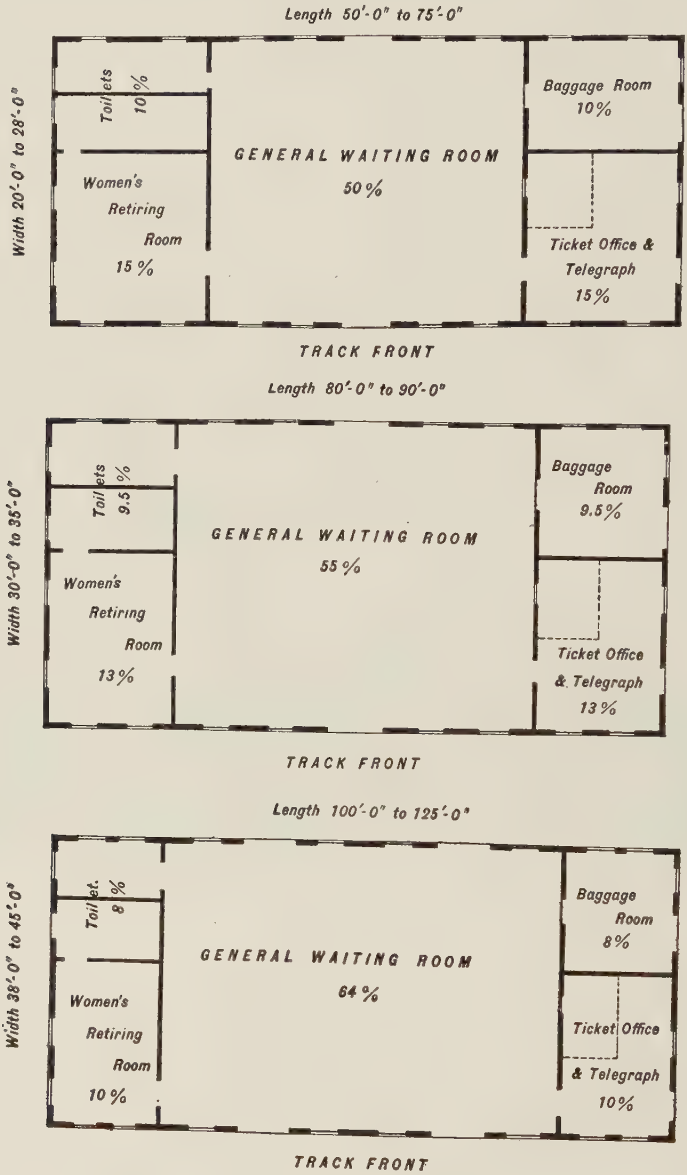


Fig. 154.—A. R. E. A. standard plans for small stations.

of the building; the women's retiring room with private entrance to its toilet room; the easy access from the agent's room to the train platform, the baggage room and the waiting room and the accessibility of the ticket and telegraph office to trainmen who have to register or to get train orders or telegrams.

The combination freight and passenger station is logically next in order but it has peculiar characteristics of its own which are treated more at length in a section below.

In the case of small stations on single-track lines it does not usually matter upon which side of the track the station is placed. It is advisable, however, to place it upon that side from which most of the persons who patronize the station come, as that will save them from crossing the tracks more than is absolutely necessary, make it much easier for carriages to approach the building and in general permit the station grounds to be confined to a smaller space.

At intermediate stations on two or more track lines, passengers frequently have to cross one track at grade in order to board or leave trains running on the farther track from the station. Such stations, therefore, should be placed on the side of the line from which the greater number of persons board trains because passengers who are about to board trains use the waiting rooms and other facilities while those who leave trains depart for their various destinations without entering the station. This means that within a certain distance of large business centers, that is to say within the suburban zone, stations should usually be on the right-hand side as one approaches the travel center. Where travel is heavy, fences are often placed between the tracks in order to prevent passengers from crossing them at grade and subways or footbridges are constructed for their use. Overhead stations with island platforms at track level are also frequently used where topographical conditions or grade elimination make them desirable. The footbridge is usually a little cheaper in point of first cost, but it is more expensive to maintain; it also limits the clearance, affords greater opportunity for accident and obstructs the engineman's view. The subway, on the other hand, requires more attention to keep it clean and also more lighting.

On four-track lines the problem of landing arrangement becomes somewhat complicated. Where the two center tracks are used by express and freight trains, it is the rule to erect a fence between each local track and its adjoining express track and to place the platforms on the outside. If it is desired at more important stations to make the middle tracks accessible also, both island platforms and fences will be found necessary unless fences are erected between the center tracks alone. In the latter case, however, enginemen and station employees must take great care that passengers crossing the outside tracks to get trains on the inside tracks are not run down. On a large part of the New Haven's four-track sys-

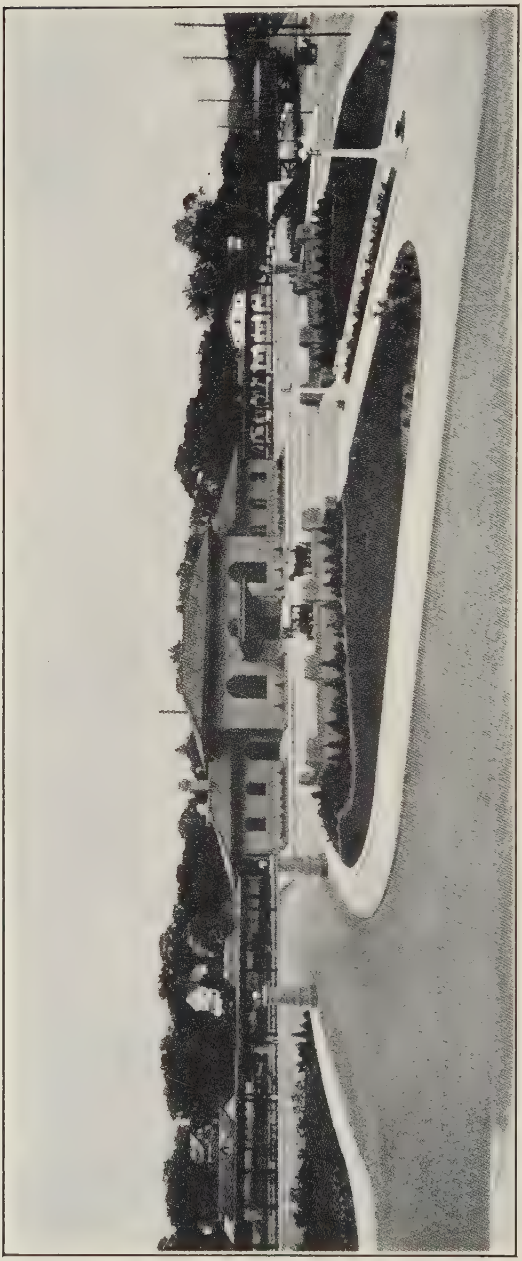


FIG. 155.—Morristown, N. J., Lackawanna.

tem, danger such as this is avoided, because, wherever possible, express trains are run on the outside tracks and the inside tracks are reserved for freight trains. Express trains can, of course, run on the inside tracks, and formerly that was the rule, but if they have a stop to make they must cross over to the outside track in order to be outside the station fences.

There is one disadvantage about these arrangements, however, that buildings are required on both sides of the track, there being a main building on one side, which should be that side on which the majority of the passengers board trains, and a smaller building with auxiliary facilities on the other. This double complement is perhaps objectionable from the standpoint of economy, but it is certainly much safer.

The New York Central has another way of avoiding the difficulty. On the road's four-track line between Albany and Buffalo it is the rule to run the passenger trains in both directions on adjacent tracks, these being the two to the right as one is coming east. All the passenger stations, therefore, excepting some of the more important ones are placed to the south of the four-track system and at any one point a single station suffices for passenger trains in both directions and no fences, footbridges or subways are necessary. The arrangement, however, has its risks.

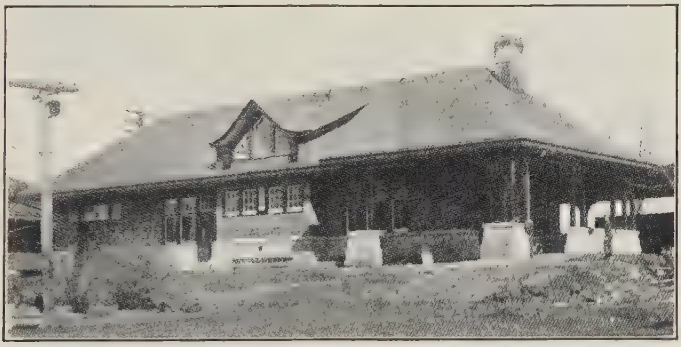
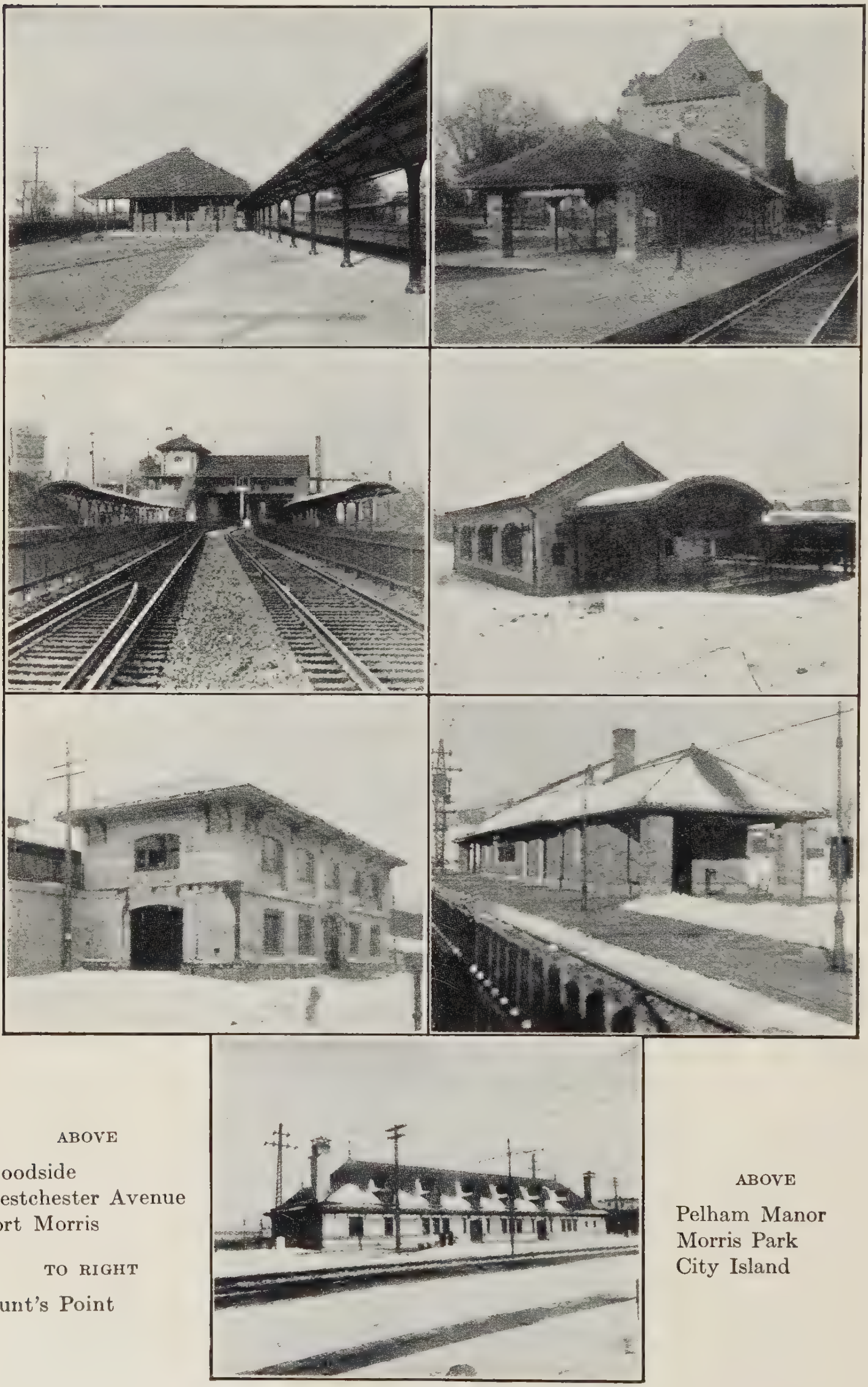


FIG. 156.—Concrete and wood station, New York Central.

Another unique application of the same idea is to be found on that part of the Boston & Albany between Boston and South Framingham. The line handles a large freight and through and local passenger business. The two tracks for local trains are the adjacent tracks to the left facing west, whereas the other two are used for freight and through passenger business. Stations handling local business only, therefore, are placed on the south side of the line and in this case again there is no necessity for fences or bridges. At Newtonville where both local and through trains stop, there are two separate stations, one for eastbound and one for westbound business. A fence has been placed between the two center



ABOVE

Woodside
Westchester Avenue
Port Morris

TO RIGHT

Hunt's Point

ABOVE

Pelham Manor
Morris Park
City Island

FIG. 157.—Stations on Harlem River Branch, New Haven.

tracks and passengers have to cross from one side to the other by an overhead bridge, which in this case, since the tracks are depressed, is the street.[1]

A few examples of two-, four- and six-track stations, showing different arrangements for reaching the tracks and trains, are shown in the illustrations herewith. The pictures in Fig. 156 are views of the New York, New Haven & Hartford's six-track stations at Port Morris, Hunt's Point, Woodside, Pelham Manor, Morris Park, Westchester Avenue and City Island, N. Y.

The illustrations, in most instances, indicate the layout and do not require much description. The buildings are of concrete, with steel framing, excepting those at City Island and Pelham Manor which are of stone. All are unusual in general design and decorative details and the character of each is dependent on its location. The Hunt's Point building is carried entirely on a bridge and was therefore made as light as possible and designed to give an impression of lightness.

The Port Morris station is built on solid ground and made correspondingly massive.

At Westchester Avenue the two ideas are combined. Part of the building is on a bridge and part on the ground. The design of each part is in keeping with its foundation.

Pelham Manor was built of stone to harmonize with an existing retaining wall which was a feature of the station approach.

The umbrella shed shown in several of the photographs is standard on this part of the line.

As regards small station architecture, some middle ground should be chosen between those exceedingly plain affairs which look as though they were measured off by the yard to fit the size of the town and those painfully elaborate affairs which run more to striking architectural beauty than to utility. An instance is recalled of a station erected in a prosperous New England manufacturing town, where travel was spasmodically very heavy. The building was adorned with many alcoves, inside and out, which served no useful purpose but necessistated, on the other hand, considerable expense to light the dark corners, a large amount of effort to clean and much trouble as far as the maintaining of decorum was concerned. The ordinary wayside passenger station is not the proper field for the architect who wishes to rival the designer of the Paris Opera House.

The designing of small stations does, however, offer a very good field for the architect with substantial ideas of neatness and economy. There are in the United States approximately 85,000 passenger or combination freight and passenger stations and it has been estimated that of these,

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[1] When necessary to stop an express train at a local station (other than Newtonville) the train is diverted to the local track.

80,000 cost less than $25,000 each. When it is realized that the $11,000,000 expended on the station building in Kansas City would pay for 1,100 stations valued at $10,000 each it will be more readily seen wherein lie the opportunities for the designer of small stations.

In determining the size of a small station building too much dependence must not be placed on the size of the community. This should be so self-evident as not to need mention, but there are a few too many cases where it has not been observed. To illustrate, the station sufficiently large for one town of 10,000 inhabitants would not be at all adequate for a neighboring college town of like population. The students in the latter town are continually traveling and would simply overwhelm the facilities of the station at the beginning and end of term time and in the holidays.[1] Very special care must always be taken to secure sufficiently comfortable and adequate facilities at junction points. The business using the stations at such places may be many times the traffic secured from the community immediately adjacent.

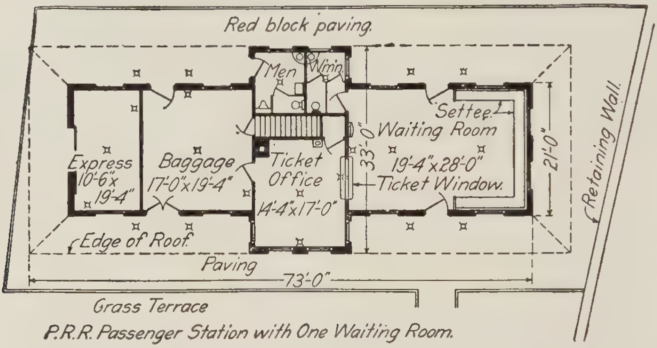

Fig. 158.—Plan of small station, Pennsylvania Railroad.

The style of architecture to be followed is very largely a matter of common sense. The railways in this regard seem to have acquired in the last few years an unusual success at producing something at least slightly better than the surrounding buildings. In former years railway stations were almost noted for being in the poorest and dirtiest parts of the communities which used them. The realization of the importance of the railway station as an element of civic pride and the railway's attempts at coöperation in this respect have certainly effected a great improvement. Whether the carriers' efforts have been appreciated some will doubt, but he who can look upon an attractive railway station layout and not feel a certain amount of satisfaction at the railway's efforts to encourage his

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[1] Wellesley, Mass. (Boston & Albany), may be cited as an illustration. The station is architecturally beautiful and sufficiently commodious for normal business, but is very much overtaxed, particularly its baggage facilities, when the college opens and closes, and at vacation periods.

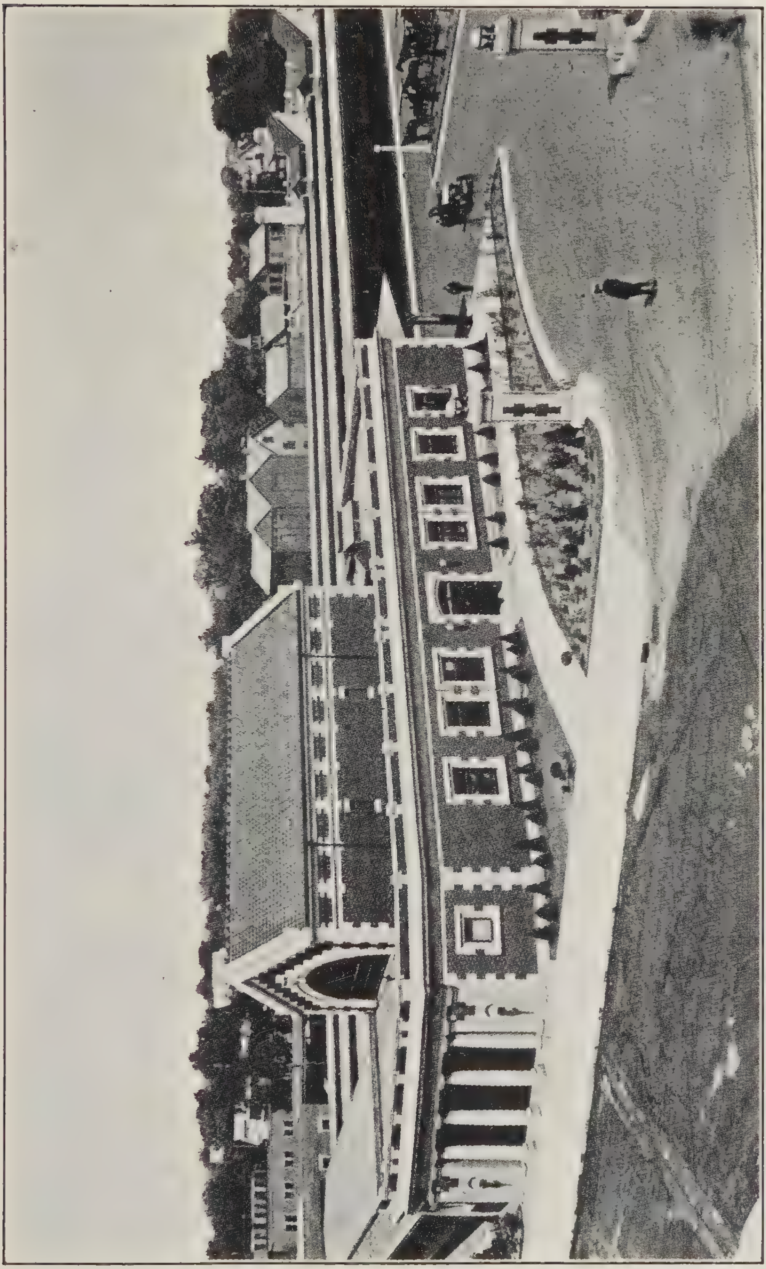


FIG. 159.—Lackawanna station, Montclair, N. J.

city's civic pride must have an ingrown grouch or else a heart of stone. The vote of thanks given the Lackawanna by the people of Montclair, N. J., when the railway built a new station in that town is not sufficiently unusual to be remarkable.

The importance of attractiveness in small stations has been realized by some of the railways for many years. The Boston & Albany is a notable example, the stations on its main line from Boston to Albany being of an unusually attractive character.

On many roads much dependence is placed on standard designs for the smaller stations. This idea has a great deal to commend it but if it is followed some care must be taken to vary the principle as necessity demands. If all the stations adhere closely to one design there is a chance that the sameness may prove monotonous. There is something, too, in not neglecting to observe the influence of the varying architecture of the various communities, although it is true that our American towns, or to be more exact, those towns in any large section of America, do follow closely one general appearance. Much leeway is obtainable by adopting the standard design in its essentials but in varying the exterior trimmings sufficiently to suit the needs or to overcome the danger of sameness in the various stations.

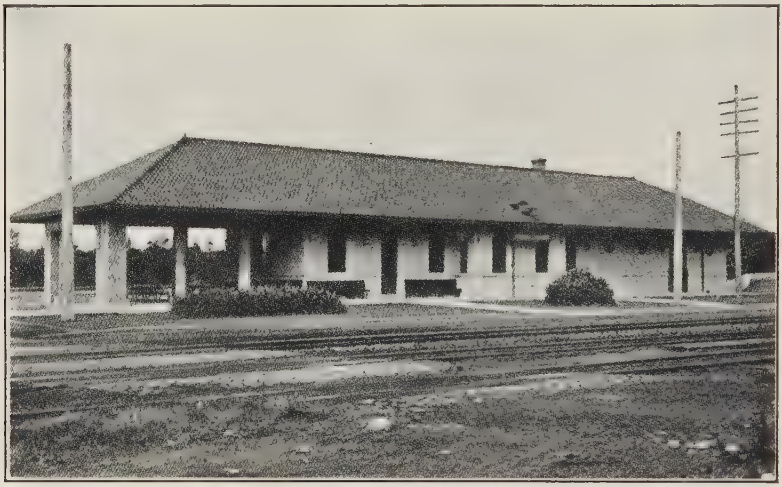
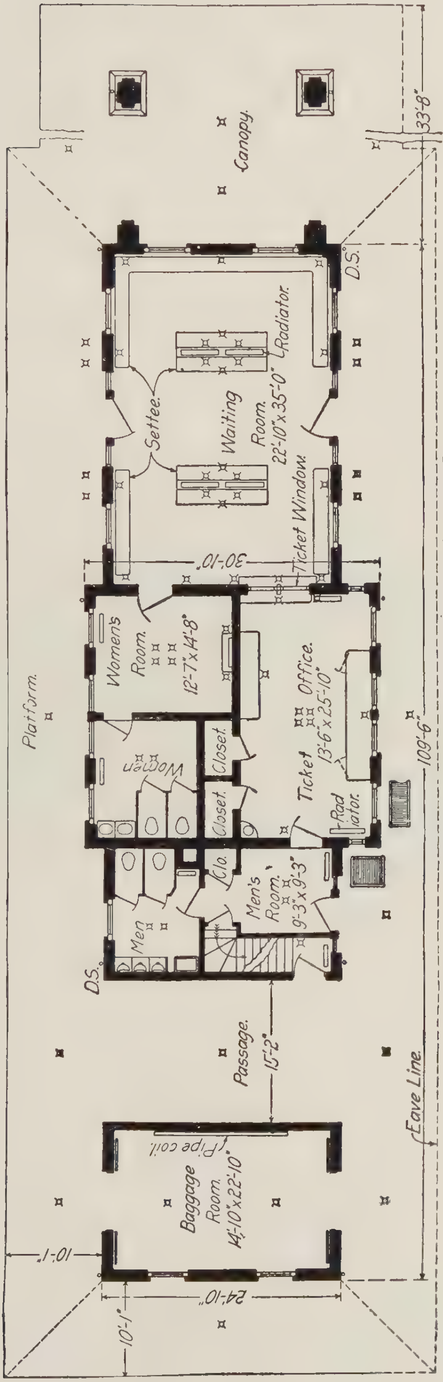


FIG. 160.—Concrete station, Lackawanna.

The matter of size has been briefly touched upon above. This is purely a matter of individual consideration and no hard and fast rules can be stated. The station plans shown herewith will give some idea of the practice on a number of important roads.

The railways as a general thing are gradually ceasing to use wooden frame structures for their small passenger stations, and some lines, such



L.V. Station with Main Waiting Room and Small Men's and Women's Rooms.

FIG. 161.—Plan of small station on Lehigh Valley.

as the Lehigh Valley or Lackawanna, have practically ceased entirely. Buildings of this type cost from about $1,000 to $5,000 and are used on most of the large systems only for very small stations or for temporary construction. The Santa Fe, for example, builds frame stations only on new lines and replaces them as soon as the community develops sufficiently to demand it. The structures range in size from 16 ft. by 40 ft. to 24 ft. by 65 ft. and 24 ft. by 80 ft. and cost about $1,200, $2,200 and $3,000 respectively. No frame structures are built, however, to replace existing structures.

Wooden frame buildings on most roads are being superseded by structures with walls of brick, stucco, concrete, terra cotta, natural stone or similar materials. Brick stations, 1,000 to 3,000 sq. ft. in size, cost in the neighborhood of $3.00 to $5.00 per square foot, are always found fitting and durable and lend themselves to attractive designs. The tendency is toward the use of dark colors with natural stone, terra cotta or concrete trimmings. Stucco is very satisfactory for use above the lower window sills but if used below that level is too susceptible to damage by trucks. The stucco may be put on over a frame or hollow-tile construction, it being the practice on some roads to make the part of the structure below the window sills of brick. A station of this kind with hollow-tile construction above the level of the window sills should cost about $3.00 to $5.00 per square foot. Some lines have used brick with a stuccoed surface, this being slightly more expensive. The Burlington has built stations 24 ft. by 82 ft. in size with frame walls stuccoed at a cost of $3,000 not including heating, lighting or fixtures; a similar building with tile walls costs about $1,000 more. The Lackawanna has built a number of concrete buildings of peculiarly attractive appearance as will be seen from

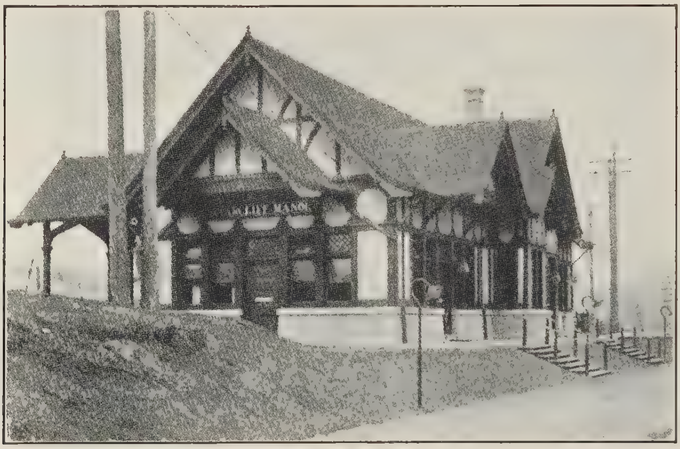


FIG. 162.—Concrete and stucco station, New York Central.

the illustration of one of them. The objection to concrete has been the difficulty of lining thin high walls and the extra care required to secure a pleasing exterior. The Lackawanna uses a bush-hammered or bull-pointed surface and tops the structure with a red tile roof. This road has also used terra cotta buildings and has tried brick veneered walls, placing the brick facing on a tile wall.

It seems to be the tendency in small station design to use a roof with wide overhanging eaves. Tar paper or other prepared roofing is used on very small structures but on medium-sized stations preference is given to slate or tile.

It is almost the rule in small station construction to plaster the interior walls above the wainscot, many large roads using metal lath in this connection. Plaster or wall board is also coming to be used extensively. The wainscots usually extend to a height of from 5 to 9 ft. and are most frequently made of wood, although some roads, such as the Lehigh Valley and the Lackawanna, make an extensive use of tile and others prefer an impervious or an enameled brick. Partitions are usually built of brick, hollow tile or timber, the last being both the least desirable and the least expensive.

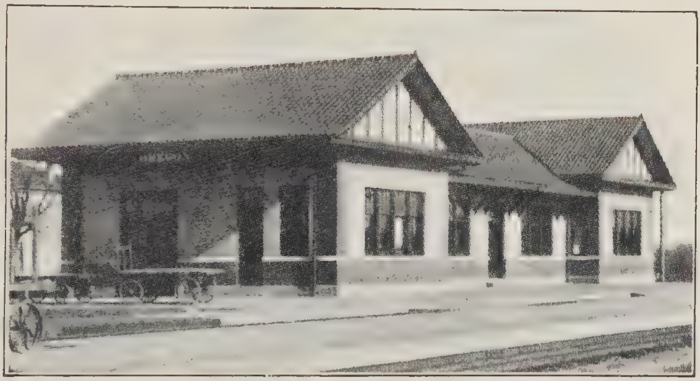


FIG. 163.—Brick station, Burlington.

The wooden floors that were once in common use in all small railway stations always suffered from the handicap that they were not sanitary or fireproof and did not have a very long life. On that account they are gradually being superseded by floors of tile or other material. Some railways have also used concrete, making possibly a reinforced-concrete floor with a cement tile surface. The Lackawanna has confined itself almost exclusively to granolithic and terrazo floors.

It is not so long since every small railway station had in its middle a fiery furnace that under favorable conditions gave out sufficient heat to make the room in which it stood as comfortable as the home of the fiends incarnate. More recently the heating of stations has been reduced to something more scientific. Stoves are still used in the smallest stations but in the medium-sized structures steam or hot water plants are used. A steam heater is less in first cost than a hot water heater but the latter uses less fuel and is the cheaper to maintain. The hot water heater is also somewhat safer. The heating plants are sometimes located in a basement but may be placed in the baggage room or, if the station is a combination one, in the space reserved for freight. The radiators are commonly placed along the walls near the doors or windows, but it is considered better practice to place them behind the seats if the latter are back to the wall or between the rows of seats if they are placed back to back.

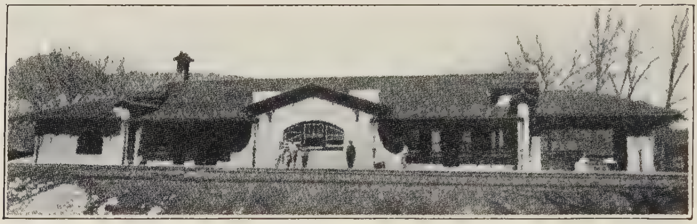


Fig. 164.—Small station in Southwest, Santa Fe.

Much can be and is being done to make the surroundings of small passenger stations more attractive in the way of care in laying out the grounds, planting shrubbery and maintaining neat walks. Railway station grounds offer an exceptional opportunity for landscape gardening in its proper sense. The scheme of planting tender greenhouse material that has been so frequently followed in the past is neither appropriate nor satisfactory and that because it is both expensive and temporary. The beds have to be renewed each year and in a northern climate last but a few months at best, thus leaving the ground bare and unsightly from the time of the first fall of snow until the warm weather in April or May. It is far better to use hardy material such as trees, shrubs and hardy

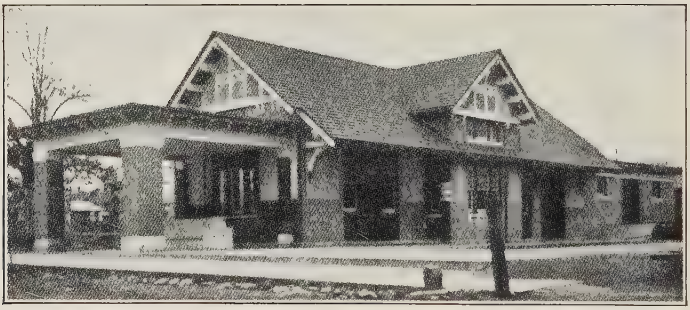


Fig. 165.—Brick and stucco building on Rock Island.

herbaceous plants. These are cheaper, the plantings perennial, they give a more natural effect and are attractive throughout the entire twelve months of the year.

Emergency and economical plantings also play an important part in railway gardening in addition to the purely ornamental. There is included the providing of such things as screens to close from view unsightly features along the right of way which are beyond the management's control, hedges along the property lines or snow hedges to protect cuts from filling up with snow. There may also be included the planting of timber for posts, crossties and telegraph poles. The usual and perhaps the most attractive arrangement is that presenting to the traveler on the passing train an area of well-kept rich green lawn fringed by a background of masses of shrubs with a varying sky line.

Combination stations are usually to be found at those points where the freight and passenger business handled is only comparatively small, and where in general it seems most desirable from economical and other operating reasons to have all the station work done under a single roof.

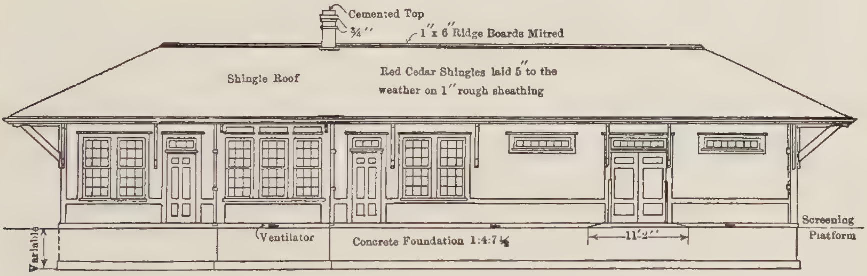

Cemented Top
3/4''
1''x 6'' Ridge Boards Mitred
Shingle Roof
Red Cedar Shingles laid 5'' to the weather on 1'' rough sheathing
Ventilator
Concrete Foundation 1:4:7½
11'-2''
Screening Platform
Variable

FIG. 166.—Elevation of combination station on Virginian.

It is difficult for the averge operating man to understand why so many separate freight and passenger stations have been built at minor points. The only argument the author has ever heard advanced in their favor was presented by an engineer of considerable reputation, who said that in case one building was destroyed by fire, the business might be handled temporarily in the other. The separation of the buildings at these smaller points, on the other hand, tends to reduce the opportunity of supervision on the part of the agent and his assistants (if he has any assistants); results in poorer attention to the patrons, and causes inferior service on the train wire, for while the agent is in the freight house, the work in the passenger station is neglected and *vice versa.*

As far as the details of construction are concerned it is well to keep a few points in mind. The office of the station should be near the center of the building fronting on the track side and if it extends across the station should preferably separate the freight from the passenger part of the structure. It should have a bay-window arrangement on the front to enable its occupants to see up and down the track. If the business is large enough to demand it, more than one waiting room may be provided or there may also be additional toilet facilities and separate rooms for express and mail. On the other hand, in sparsely settled communities it may be found desirable to erect a two-story building providing living rooms overhead for the agent and his family.

The ticket window opening from the office to the waiting room should be so located as to permit the ticket cases, shelves and money drawer to be placed conveniently alongside in such a position as not to interfere with the work which has to be done at the agent's desk or the telegraph instruments. In cases where trainmen, freight handlers or teamsters have much occasion to confer with the office force it is usually preferable to have an entrance to the office that does not lead through the waiting rooms. In the smaller stations, however, such refinements are unnecessary and may be ignored with the consequent lessening of the construction cost.

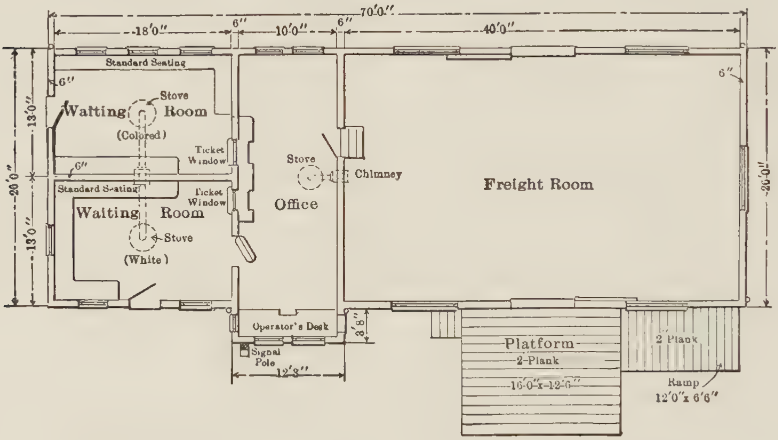


FIG. 167.—Plan of standard combination station on Viginian.

Although it is often advantageous to have a carload track in the rear of a small freight house, it is objectionable, on the other hand, to have one at the combination station, because passengers are compelled to cross it to reach the station or the platforms; it is also made more difficult to reach the station with carriages. The determination of this point, however, is one that will depend largely upon the amount of the passenger business and its importance. In some instances, therefore, a side track in front of the station—between it and the main track—may be desirable. In that case, cars left for loading or unloading will be placed on this side track at the freight end of the building and as far from the passenger end

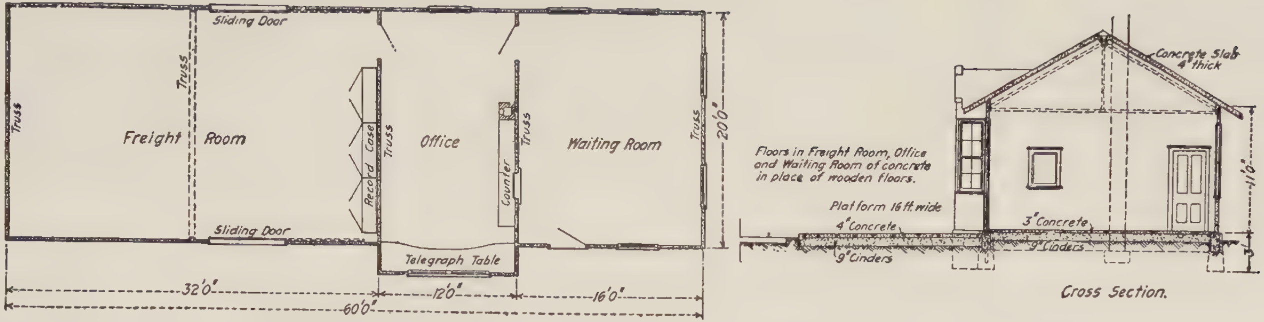
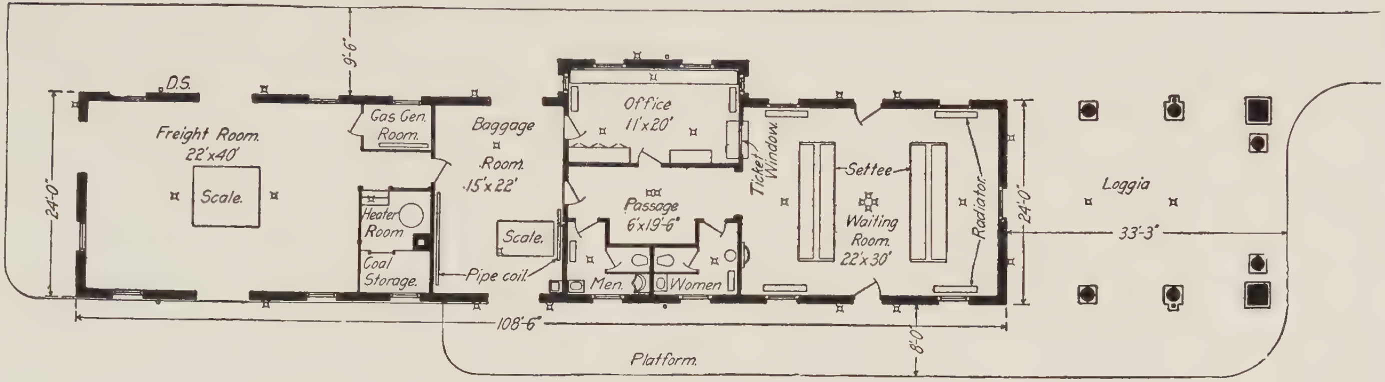


FIG. 168.—Plan and cross-section of combination station on Wabash.



D.L.&W. Combination Station with Separate Freight and Baggage Rooms.

FIG. 169.—Plan of combination station, Lackawanna.

as possible. The passengers, however, will have to cross the track to get to their trains and skids will have to be used to handle freight from cars on the main track to the platform. It is presupposed, of course, that the cars handled on the side track will contain l.c.l. or package freight. If the business to be handled is in solid carloads, however, it would be better to omit the track in front of the station and to arrange instead for the use of a team or bulk-delivery track beside a wagon road and in proximity to the station and its grounds.

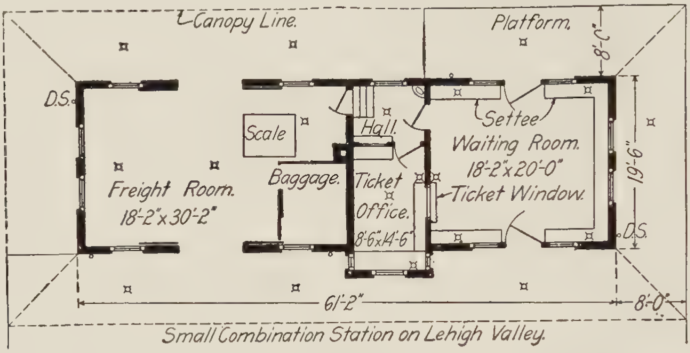


FIG. 170.—Plan of combination station, Lehigh Valley.

Many opinions and views are entertained as to the most suitable height of the platforms for the combination station. In this again the stereotyped statement may be used as before—"it depends on conditions." Where the freight business predominates, and the number of passengers is insignificant, a high platform equal in height to a car floor will be found cheapest and best. If the passenger and freight business are both relatively important, a combination of high and low platforms should be introduced, the high platform extending around the freight house portion of the building except possibly along the end and the low platform around the passenger station portion. The high platform may also be extended along the track for some distance to provide for more cars. It is usually the rule to construct an incline between the high and the low platforms if both are used. If there is no track between the main track and the building, it is considered good practice to place a low platform the entire length of the building with a high platform about the freight house section.

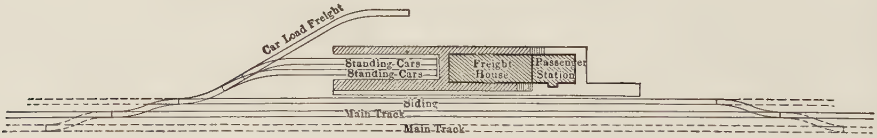


FIG. 171.—Berg's typical combination station.

A typical layout for a combination station is shown in Fig. 171. This was designed by the late Walter G. Berg. It provides all the usual freight house facilities and has room for l.c.l. cars on tracks adjacent to both the freight house and the platforms as well as a c.l. or solid car track.

In this plan the obvious advantages are: a low platform for passengers; a high platform for freight; platform frontage for cars to be unloaded into the house; a siding in front to permit trains to do station work or to rearrange cars for other reasons; a team track readily accessible for teams and the arrangement whereby carriages may reach the passenger end of the station without crossing tracks or becoming pocketed between them. The principal objection to the plan, however, is the necessity for passengers to cross the side track in front of the station to reach their trains.

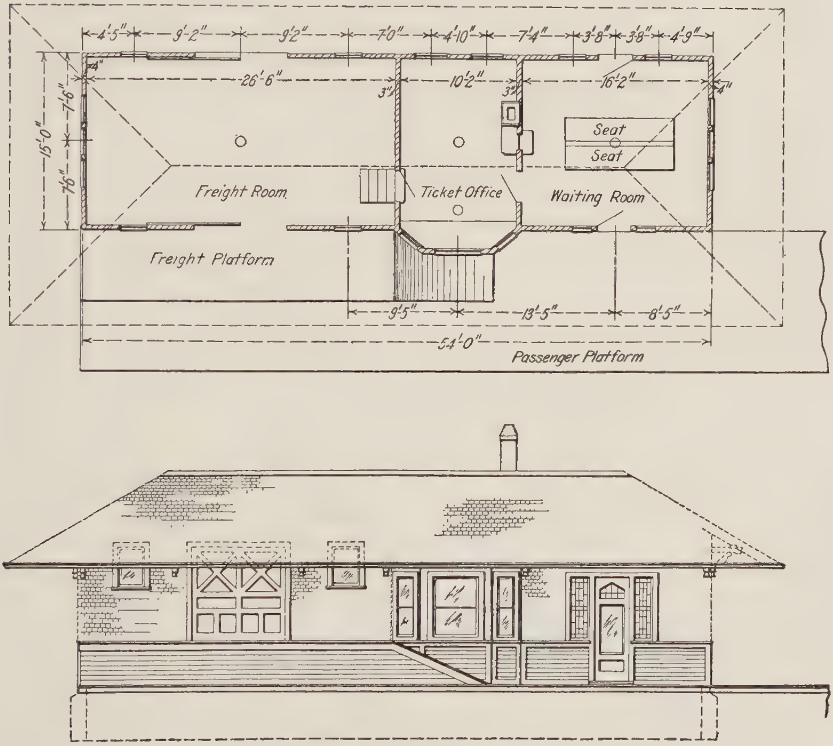


Fig. 172.—New Haven standard combination station, plan and elevation.

The plan and elevation in Fig. 172 are of the standard combination station buildings used by the New York, New Haven & Hartford. The size, of course, is varied to fit conditions and in many instances the station is so constructed as to permit of addition to or lengthening of the passenger or freight house end or both, should increasing business demand it. There is little that is original in the plan—everything about it has been used for many years—but it is particularly commendable for its adoption and combination of much, if not all, that is good in other stations. It has been in use, with slight variation, at many points and for several years, and has thoroughly stood the test of service.

CHAPTER XVI

PASSENGER TRAINS AND TERMINALS OF FOREIGN COUNTRIES

The methods of foreign roads are those peculiarly adapted to the customs and conditions of the countries they serve; and it is, therefore, unwise, to say the least, to attempt comparisons to the detriment of the roads on one side of the water or the other.

In England[1] railways entering the larger cities, and London in particular, handle, in addition to their long distance trains, an immense number of suburban trains, running over an intricate network of short lines. The complication is increased because in order to accommodate the commuters trains must be run from each of these branch lines, not merely to and from one terminal in the city, but to and from two or three different stations maintained by the company itself, and also to and from several other city terminals of other companies, whose lines and stations as well as those of the local London District Railway are used in common for this service by agreement. A commuter may choose the one of a number of terminal stations which is nearest to his business, and is thus saved considerable time. The complicated problems involved, however, and the congestion of traffic at some of the junctions and terminals, are unequalled even at the most important stations in America. The safe and prompt hauling of this enormous traffic, especially during the foggy weather around London from fall to spring, does honor to all concerned.

The difficulties of caring properly for a heavy suburban business may be made clear by a study of the London situation. During the month of October, 1907, 9,743,669 passengers entered London by railway from the suburban districts—including the zone within 30 miles of London Charing Cross Station—and of these, 8,671,785—nearly 83 per cent.—came from distances not exceeding 10 miles from Charing Cross; more than 8.5 per cent. came from 10 to 12 miles; and less than 8.5 per cent. from between 12 and 30 miles. The accompanying table showing a summary of this study and giving the total number of passengers entering London per month from each zone, the area of each zone and the number of passengers per square mile, is interesting.

The number of people who live in the country and travel daily to their business in London is constantly increasing. Such people measure distance by time rather than miles, and the further the railways will carry them within an hour, the further they will go. At the end of 1907, 4,000 season tickets were in use between Southend and Fenchurch Street, a distance of 36 miles—covered by the fastest trains in 50 minutes. There are many who come up to London daily from places as far distant as Brighton, 50.5 miles.

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[1] A series of articles on the railways of England appeared in the Railway Age Gazette of May 7, 14, 21, 28, and June 4, 1909.

TABLE I

Zone	Dist. from Charing Cross, miles	Area in square miles	Passengers	
			No.	No. per square mile
1	4–6	63	2,232,201	35,584
2	6–8	88	3,406,588	38,729
3	8–10	113	2,432,996	21,512
4	10–12	138	843,780	6,104
5	12–15	244	238,252	977
6	15–20	560	331,213	592
7	20–25	707	151,025	213
8	25–30	864	107,614	124

On the English railways a great many through cars are run to places off the line over which the rest of the train goes to its destination, these cars being switched off at junction points and attached to trains which run over other branches of the same road, and sometimes even over the lines of other, and competing roads. This permits a direct service by the shortest possible route, and is very convenient as the service given is not only for long distances, but for comparatively short ones.

At an English station passengers are not allowed to cross the tracks in any other way except by the bridge over the tracks or a subway under them, one or the other means being always provided. The enforcement of the rule is made easy by the construction of the platforms, which are about level with the floors of the cars as in the Pennsylvania and Grand Central Terminals in New York. The train starts without shock, and if a locomotive or car is coupled to the train it is done without discomfort to the passengers. This coupling being adjusted by hand for each car cannot be completed as quickly as an automatic coupler, but it obviates the violent concussions incident to the use of the latter. The railways are well protected by block signals; the lines are well fenced or hedged to keep off trespassers, and never crossed at grade by other railways. There are also no highway grade crossings except in a few parts of the country where the ground is very flat, and the crossings are then protected by heavy gates (not mere bars), carrying lights at night, which either completely close the highway, or, when the latter is open, swing across the tracks so that a train cannot pass without smashing them. This makes accidents less numerous than in America, though the orderly habits of the people, and a strict enforcement of laws against trespassing, probably go far toward reducing the number of people killed or injured when crossing or walking along the tracks. The rule of avoiding grade crossings has been followed from the beginning of railway construction in England.

TABLE II.—NUMBER OF ORDINARY PASSENGERS WHO TRAVELED TO LONDON BY RAILWAY IN THE MONTH OF OCTOBER, 1907, FROM SUBURBAN STATIONS WITHIN CERTAIN DISTANCES OF CHARING CROSS

Railway	Miles								Totals
	4 to 6	6 to 8	8 to 10	10 to 12	12 to 15	15 to 20	20 to 25	25 to 30	
Great Eastern	229,464	1,091,986	495,036	161,911	55,233	13,899	7,760		2,055,298
London & South-Western	141,301	120,710	750,203	143,674	29,911	85,842	12,273	13,468	1,297,382
Midland	59,976	51,470	5,503		12,877	33,113	14,759	20,624	201,322
London & North-Western			14,168	21,270	13,149	22,537	3,783	3,655	78,562
Great Central			5,247	12,370	12,400	7,081	4,854	5,029	46,981
Great Western		79,167	83,114	26,389	11,841	31,584	21,571	30,835	284,501
London, Tilbury & Southend[1]	2,544	45,449	55,057		2,508	19,322	16,165	6,868	147,913
Great Northern	631,684	202,572	101,306	65,923	5,679	8,755	4,942	11,838	1,032,699
London, Brighton & South Coast	357,291	258,373	81,790	150,103	14,312	14,183	11,736	4,085	891,873
Metropolitan	94,184	25,372		42,291	8,185	5,085	1,142	2,546	178,805
Metropolitan District	97,872	143,298	24,547	12,592					278,309
South-Eastern & Chatham	228,656	330,730	304,167	84,801	47,867	55,644	51,358	7,847	1,111,070
Totals	1,842,972	2,352,127	1,920,138	721,324	213,962	297,045	150,352	106,795	7,604,715

[1] There is a daily traffic from Leigh (34 miles), Westcliff (36 miles), and Southend (37 miles), which is reckoned at 125,602.

TABLE III.—NUMBER OF PASSENGERS USING WORKMEN'S TICKETS WHO TRAVELED TO LONDON BY RAILWAY IN THE MONTH OF OCTOBER, 1907, FROM SUBURBAN STATIONS WITHIN CERTAIN DISTANCES FROM CHARING CROSS

Railway	Miles								Totals
	4 to 6	6 to 8	8 to 10	10 to 12	12 to 15	15 to 20	20 to 25	25 to 30	
Great Eastern	48,215	410,600	146,384	25,165					630,364
London & South-Western	53,963	46,363	54,858	35,934	11,239	15,245			217,602
Midland	13,533	23,484	18		355	271		47	37,708
London & North-Western			3,057	8,196	4,089	11,740	160	72	27,314
Great Central			3,707	2,833					6,540
Great Western		2,120	2,218	706	300	821	513	700	7,378
London, Tilbury & Southend	21,293	260,665	157,279						439,237
Great Northern	64,989	35,378	12,464	15,494		1,645			129,970
London, Brighton & South Coast	65,468	99,051	38,121	8,294	299				211,233
Metropolitan	35,683	21,952		11,461	83	1,023			70,102
Metropolitan District	33,972	36,898	2,650	6,117					79,637
South-Eastern & Chatham	52,113	118,050	92,102	8,256	7,925	3,423			281,869
Totals	389,229	1,054,461	512,858	122,456	24,290	34,168	673	819	2,138,954

Some very interesting details of the passenger service on the state-owned railways of Prussia and Hesse before the great European war were included in an address entitled, "The Administration of the State Railways of Prussia-Hesse" read by William J. Cunningham, professor of transportation at Harvard University, before the New York Railroad Club on April 18, 1913. Professor Cunningham had spent three months in Germany in the summer of 1912 and spoke with the authority of an observant operating man. Some of the parts of the paper relating to the passenger service are here quoted:

> Altogether there are about 34,500 miles of state-owned railways, and 2,200 miles of private-owned railways, in Germany. Of the state-owned mileage Prussia has 23,335, or slightly more than two-thirds. Bavaria comes next with 14.1 per cent. Then comes Saxony with 5.1 per cent.; then respectively Alsace-Lorraine with 3.6 per cent.; Baden with 3.1 per cent.; Mecklenburg with 2.0 per cent.; and Oldenburg with 1.2 per cent. In Prussia-Hesse, the private-owned mileage is 6 per cent. of total. The private railways, however, are comparatively unimportant and are controlled by the government almost as completely as the railways of the states. They are obliged not only to conform to the state traffic regulations but as well to adopt the rules and standards set by the government for the same class of state-owned railways.
>
> **Organization.**—At the head of the railway administration of Prussia, is the minister of public works, who is appointed by and may be removed only by the king. Changes in this office are very infrequent. The minister and his councillors correspond roughly to our board of directors or executive committee and chairman; but the several councillors are railway experts, and each devotes his attention to the department in which he has specialized.
>
> The ministry deals only with general matters of policy and standards. The active administration is left to the local directorates, of which there are 21. The average mileage per directorate is 1,116. At the head of each directorate is a president, who reports to the minister of public works. The president of a directorate corresponds in a general way to our general manager, but he has control over every department on his division, including not only maintenance and operation, but also traffic, accounting, finance and construction. It will be seen, therefore, that the Prussian operating unit—the directorate—is the highest type of the divisional system of organization. Below the president the organization becomes departmental, and the lines of authority and responsibility are tightly drawn.
>
> While the principle of local autonomy in the operating of each directorate is carefully guarded, it has been found advantageous to concentrate a few functions exclusively in one of the several directorates, the one so selected to act in that particular matter for all other directorates. Besides, there is a central office in Berlin, which is rated as a directorate (making 22 in all) and attends to certain specified activities for the system as a whole. In some respects the president of the central office resembles our superintendent of transportation, but the former has wider jurisdiction, including that of our purchasing agent.
>
> Associated with the administration are two kinds of advisory or consulting bodies: (1) advisory councils, local and central, established by law; and (2) voluntary traffic and operating unions. The advisory councils are composed of rep-

resentatives of the government, and delegates from boards of trade, industry and agriculture, as well as representatives of the railway administration. The administration is obliged to consult with these advisory councils on all matters affecting rates or public service. They have no actual power to compel the railway administration to accept their recommendations, but, their recommendations are equivalent to commands. The jealousies of sections usually prevent any tinkering with tariffs, even when the administration might be willing to make a reduction which would benefit certain communities.

The advisory councils, on the whole, are to be commended, both in their negative and positive results. Through them the industrial, agricultural, and trade bodies are the arbiters of their own interests in transportation, and all persons affected by railway rates and rules of service have an opportunity to be heard before any change can be made in existing tariffs or regulations.

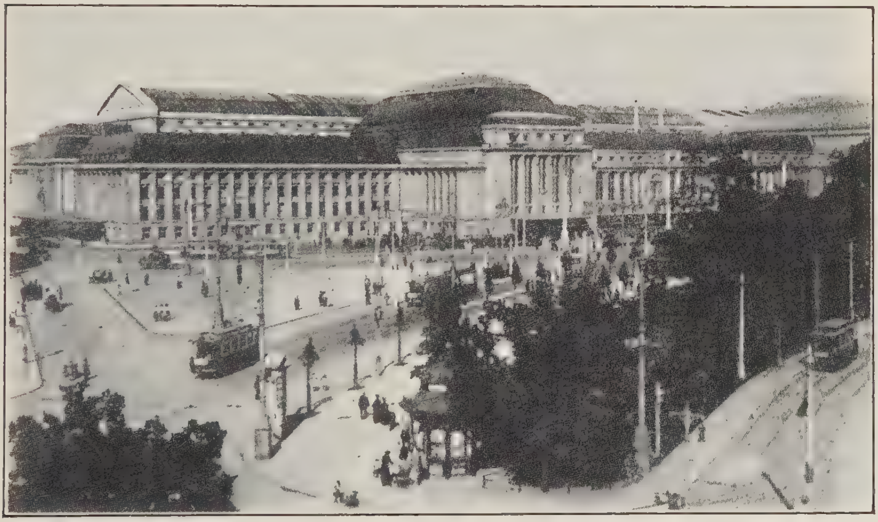

Fig. 173.—Station in Leipsic, Germany, the largest in Europe.

The American railroad man who visits behind the scenes on the Prussian railways is struck by the absolute impersonality of the organization. Authority flows from the office, and respect is accorded to the office, rather than to the man who happens to fill it. The personality of an official, which is so important here, has practically no play under the Prussian organization. Letters or instructions emanate from the directorate, and may bear the signature of any one of the officials, but in the name of the directorate.

Discipline.—It is well known that practically all of the railway employees of Prussia have served in the army. When they enter the railway ranks from the army, certain credits are allowed for their military service, and certain positions are reserved for army men. This military experience shows its influence on their deportment and discipline in railway service. There is a noticeable orderliness and precision about everything connected with German railways. In respect for authority and strict observance of the rules, the German railway employee has no superior. The traveler will not fail to notice the red-capped station master standing at attention on the station platform as the train passes through each station. He will also find the senior signalman, gatemen, and other employees connected with train service always in evidence, standing like sentries as the train passes. The operating official, while riding over the line, can thus take a census of all employees in position of responsibility. When he alights at a station his rank is at once recognized. The station master immediately salutes and gives a verbal report of the situation at his station. If the official goes into a signal tower, the signalman in charge salutes and reports. If he goes into an engine house, the foreman salutes and gives a brief report of the work in progress.

The formation of railway labor unions in Prussia is forbidden by the railway administration. The employees have associations, but inasmuch as the railway officers are *ex officio* members, and take a fairly active part in the proceedings, these associations bear little resemblance to our railway brotherhoods.

The high order of discipline and rigid observance of rules which follows their system of ample and constant supervision bears fruit in their remarkable immunity from train accident, and in the small number of passengers and employees killed or injured. Differences in the manner of compiling accident statistics make comparisons with this country difficult. It is possible, however, to make a comparison of injuries in train *collisions and derailments,* since the classification is the same in both countries and the statistics are made up on the same basis. In 1910, only two passengers lost their lives in collisions and derailments on Prussian railways. In that year they handled 1,083,882,279 passengers. In the same year the United States, with ten times the railway mileage, transported 971,683,199 passengers (112 million less than Prussia). But it must be borne in mind that our passengers traveled farther. In Prussia the average passenger journey is 14 miles; here it is 33 miles. Consequently our railways produced more passenger miles, although they handled a smaller number of passengers. Looking at it one way, it is fair to the United States to compare injuries to passengers on a basis of passenger miles. Viewing it from another angle, it may be said that collisions and derailments will tend to vary with the train miles rather than with the number of passengers. We will make the comparison on the two bases:

PASSENGERS AND EMPLOYEES KILLED AND INJURED IN COLLISIONS AND DERAILMENTS, 1910

Item	Prussia-Hesse	United States
Passengers carried 1 mile (millions)	15,688	32,338
Total revenue and non-revenue train miles (thousands)	298,584	1,276,025
Passengers killed in collisions and derailments	2	127
Passengers injured in collisions and derailments	349	6,499
Employees killed in collisions and derailments	13	608
Employees injured in collisions and derailments	162	5,201
Passenger miles per passenger killed (millions)	7,844	255
Passenger miles per passenger injured (millions)	45	5
Total train miles per passenger killed (thousands)	149,292	10,048
Total train miles per passenger injured (thousands)	856	196
Total train miles per employee killed (thousands)	22,968	2,099
Total train miles per employee injured (thousands)	1,843	245

Attention is again drawn to the fact that the foregoing tabulation includes only the injuries in *collision and derailments.* Injuries in other train accidents, falling from moving cars, highway crossing collisions, trespassing fatalities, suicides, etc., are not included in the figures for either country. Those for this country are sufficiently familiar to us. The small number of accidents to trespassers is noticeable.[1] In Prussia the laws prohibiting trespassing are strictly enforced and the railway right of way is carefully guarded. Those who trespass assume a high risk of arrest, since the tracks are well patroled. All persons detected are arrested, fined or imprisoned. The fact that 14 trespassers are killed daily on the railways of the United States,[2] although given wide publicity, has thus far made little impression on our city and county authorities.

The poor accident showing in this country is largely due to the inherent tendency of the American railroad man to take chances. In Prussia, the railway employee is more deliberate in action, and his military training gives him greater respect for the rules. It may be, too, that the methods there employed to investigate accidents and mete out punishment to the careless, have a direct bearing on their remarkable immunity from casualty. Discipline for infraction of the rules is severe. Guilty employees are not only reprimanded, suspended, fined, or dismissed, but in flagrant cases they are imprisoned. In 1910, there were 132 cases of criminal prosecution, and 81 employees were given court sentences.

Compensation of Employees.—Turning now to the question of salaries and wages, it is interesting to note that in 1910 the average yearly wages of the Prussian railway forces, including all officials as well as workmen, was only $380 per employee. The official statistics show that the average number of "rest days" per month was 3.44 for all employees whose duties require any Sunday work. This gives an average of 324 working days, and an average daily compensation of $1.17. The writer has not sufficient information to hazard a guess as to how much more should be added to that average to allow for the supplementary allowances. He believes, however, that it is within the bounds of reasonable accuracy to say that the gross income of the Prussian employee is just about one-half the average wages of the American railway man. The general average for this country in 1910 is given by the Interstate Commerce Commission as $2.14 per day, excluding officials, but the accuracy of the figure is open to question because of differences in methods employed by different railways in compiling the basic figures. It must be remembered, however, in making comparisons between the two countries, that the cost of living is considerably lower in Prussia, and the purchasing power of the dollar is correspondingly greater.

An examination of the list of salaries, etc., shows that the financial reward for the officials is striking in its moderation. The presidents of the various directorates receive but $2,900 per year and a free dwelling. The honor and prestige which go with the position are rated high and evidently compensate for the lack of salary. His assistants, in addition to free dwellings, are paid $1,000 per year for the first three years, and a small amount is added every three years until they reach the maximum of $1,720, after 18 years of service.

On a road mileage basis Prussia has 21 employees per mile. The average in group 2 of this country is 16 per mile, and in the whole United States 7 per mile.

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[1] Killed 180; injured 145.

[2] In Prussia, one trespasser was killed every second day.

Physical Characteristics.—Turning now to a consideration of the physical characteristics of the Prussian railway system as it is today, we will first examine its trackage facilities. Serving as it does such a thickly populated district (about 300 per square mile) and having such dense traffic (as will be apparent from the figures to be presented later) we naturally expect to find the lines well equipped with multiple running tracks. Nearly one-half of the system has two or more tracks. In group 2 of the United States (comprising the railways of New York, New Jersey, Pennsylvania, Maryland and Delaware) the territory in this country which comes nearest to resembling Prussia in population and railway development, the percentage of two or more running tracks is practically the same as in Prussia, but in the United States as a whole, only 10.5 per cent. of the railways have two or more tracks. The comparative figures which follow may be of interest:

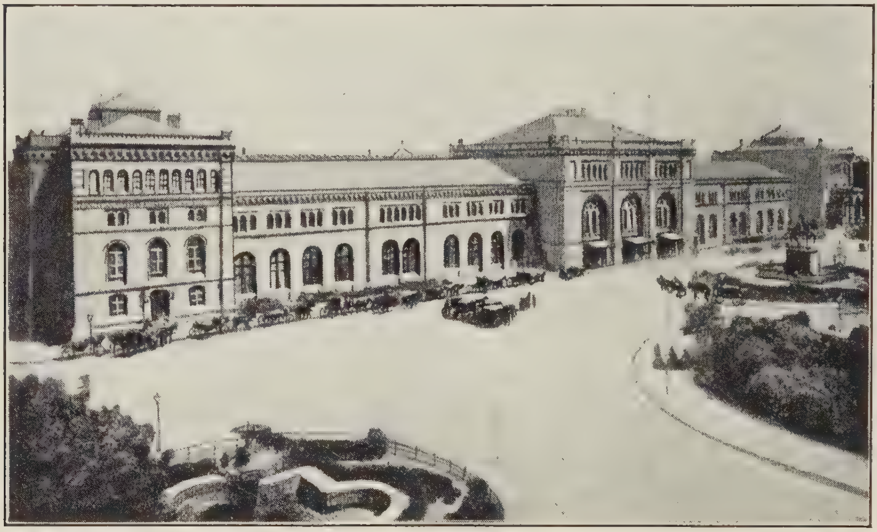

Fig. 174.—Station in Hanover, Germany.[1]

Track Density in Prussia-Hesse and United States, 1910

Trackage	Prussia-Hesse		Group 2: U. S. A.		United States	
	Track, miles	Per cent. of road miles	Track, miles	Per cent. of road miles	Track, miles	Per cent. of road miles
Single track	23,364	100.0	23,815	100.0	240,831	100.0
Second track	9,807	42.1	7,609	32.0	21,659	9.0
Third track	44	0.2	1,284	5.4	2,206	0.9
Four or more tracks	119	0.5	941	4.0	1,489	0.6
Yards and sidings	15,287	65.4	16,101	67.6	85,582	35.5
Total trackage	48,621	208.2	49,750	209.0	351,767	146.0

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[1] This figure and Figs. 175, 177, 178. 179, 180 and 181 are reproduced from the Transactions of the American Society of Civil Engineers, Vol. LIV. Part F. (1904).

The Prussian roadbed, particularly on the main lines, is well built and well maintained. Steel rail, of design similar to ours, and weighing 91 lb. per yard is now standard, but the greater part of the mileage still has the lighter rail, averaging between 70 and 75 lb. per yard. Crushed stone and gravel predominate as ballast, the former being generally used on the important lines.

Station, siding and yard facilities at many points, particularly near the frontiers, seem entirely too generous for the regular freight and passenger traffic. The explanation lies in the possible need of these facilities for the handling of troops and military supplies. All freight cars are stenciled to show capacity not only for freight but also for men and horses. A timetable for military operation is ready for use on short notice, and in the event of war, the trains for troops, horses, guns and supplies would take precedence over all other traffic.

The passenger stations in the cities, particularly the stations built within the last 15 years, are imposing in design, generous in size and trackage facilities, and well equipped to take care of the needs and comfort of the maximum traffic. The Hamburg main station is a good example. Those at Cologne, Frankfort Darmstadt and Halle are notable. The latest and most magnificent, as well as the largest station in Europe, has just been completed in Leipsic at a total cost of upward of $40,000,000. It has 22 tracks under one train shed. In Berlin there are several large stations to serve the different lines radiating therefrom, but there is no central or union station. All the Berlin passenger stations are connected by the north and south rings—belt lines which carry an enormous passenger traffic. Conditions on these belt lines, which intersect both the business and residential sections, seem ideal for electric operation, but the service is still steam operated, although electrification has been under consideration for several years.

The frequency of fixed signals and signal cabins is noticeable. All are of the manual or manual control type. The Germans do not take kindly to automatic signals. They prefer to rely upon the signalman. When asked why they do not consider the adoption of the automatic signal, which has been developed here to such a high degree of perfection, they usually turn the conversation to train accidents and inquire why it is that America has such an unenviable record in that respect.

The official statistics show that Prussia has 40,916 home signals (1.7 per mile of line) and nearly 15,000 distant signals. There is one interlocking cabin for every 5¾ miles. Grouping together all signal towers, cabins, and block stations, there is one for every ½ mile of line. On 2,800 miles of line where speed restrictions apply, automatic speed recording devices are installed alongside the track, and the records are carefully checked to insure strict adherence to the rules.

Locomotives.—The Prussian passenger locomotive on through trains is considerably lighter than ours, but there is not as much difference as is generally supposed. In that class of service the Atlantic and ten-wheel type predominate. A large proportion of all locomotives is of the compound type. Germany is the home of the superheater and nearly all engines are equipped with the device, as well as feedwater heaters, draft regulators, screw reversing gear, and other appliances which are not common here. The interior of the cab, especially in those equipped also with cab signals, seems somewhat complicated to the American observer.

The tank locomotive, which is comparatively light, appears to be the favorite in local passenger service. Freight locomotives vary in size, but most of them are little more than half the size of our freight locomotive. With the small freight cars and light grades of the main lines, the length rather than the weight of the train is the controlling features, and heavy engines are not needed. In southern Germany, however, where the grades are heavier, there are many locomotives which in weight and power compare favorably with those of the American consolidation type.

In 1910, Prussia had 19,670 locomotives of all kinds. This is an average of 84 locomotives per 100 miles of line. The average for the United States in the same year was 25, but in group 2 it was 57. The average weight of all Prussian locomotives, including tender, was 59 tons. For the United States, the average weight was 73 tons exclusive of tender. Without knowledge of the weight of the tender, and the proportion of tank locomotives in each country, it is impossible to make an exact comparison, but in the judgment of the writer, it is close to the mark to say that the Prussian passenger locomotive is about two-thirds the size of the American passenger locomotive, and the Prussian freight locomotive about one-half the size of ours.

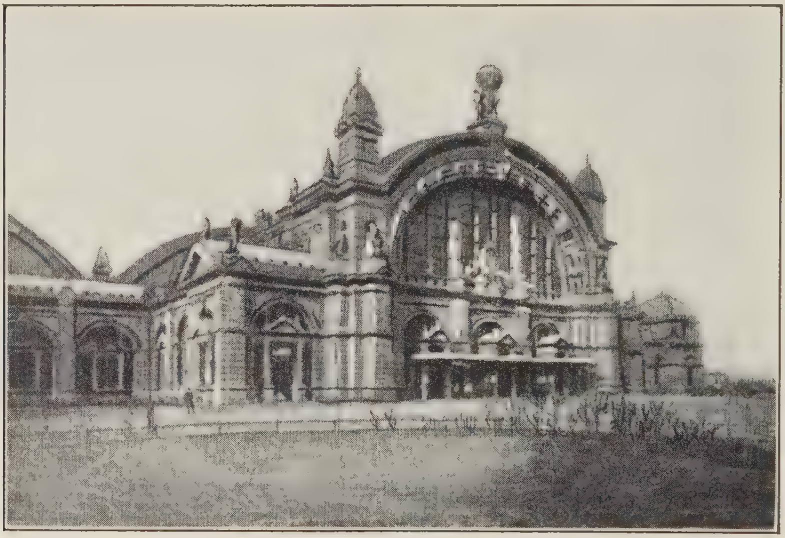

FIG. 175.—Frankfort Station.

The cost of maintaining locomotives in Prussia in 1910 averaged 4.8 cts. per mile, which indicates commendable efficiency even when due allowance is made for their small size. Failures are infrequent and the locomotives generally have the appearance of being well maintained. The Prussian policy differs from ours in that they expect and obtain a comparatively long life from their locomotives. The average life of all locomotives in 1910 was 10.2 years. One was 40 years old; 10 were 37 years old; 9 were 35 years old; 10 were 33 years old. One-quarter of the entire equipment ranged from 10 to 20 years in service; 45 per cent. ran from 5 to 10 years; and 22 per cent. had an average age of less than 5 years. The average mileage per locomotive in 1910 was 25,600. The same average for this country was approximately 29,100.

The Prussian statistics showing the performance of locomotives (and in fact all of their statistics) are remarkably complete. Among other things they give the number of days all locomotives were in service, the per cent. of time in actual use, and the per cent. of time they were in the shops for repairs. They were actually used in train service 32.79 per cent. of their time; 18.91 per cent. of their time was spent in the shops for repairs; leaving 48.3 per cent. of the time when they were idle in or near the engine house. The high proportion of time idle is accounted for by their policy of single crewing. When not single-crewed, it is the general practice to assign one engine to two crews. Enginemen are required to do much of the light running repairs themselves, and on single-crewed engines the fireman is required to report at the engine house two hours in advance of leaving time, in which to kindle the fire and get up steam. At the end of the trip it is his duty to clean the fire and do other work which here is done by the engine house forces.

Careful attention is paid to fuel economy, and premiums are paid to engine crews for economic results.

Passenger Cars.—The passenger cars of Prussia conform to the usual European design of separate compartments. The older type, used exclusively in suburban and local service, has doors on each side of each compartment, and when the train is in motion the only means of communication between cars or between compartments of different classes is by the running board on the outside of the car. This, of course, is used only by the trainmen and by them rarely.

Altogether there are 51,703 passenger, baggage and mail cars in Prussia, or 222 per 100 miles of line. In group 2 of the United States the passenger train car density is 52; in the United States as a whole, 20. Of the Prussian equipment 68 per cent. have side entrances and 32 per cent. have end doors and vestibules. The latter are used almost exclusively in through trains. More than half of the passenger cars have three axles, one under each end of the car and one under the center; 33 per cent. have but two axles; and the remaining 13 per cent. are of the modern type for the best trains and have four or six axles. Averaging all passenger train cars, the number of axles per car is 2.72. The older type of two- or three-axle car with side doors is very small and weighs about 20 tons. The modern corridor car, with four or six axles, is 60 ft. long, 9½ ft. wide, and weighs from 45 to 55 tons. The capacity of the car depends upon the classification of the compartments. There are four classes. First-class compartments seat four passengers (two per seat); second-class, six passengers; third-class eight passengers. Fourth-class compartments are much larger, but only a limited number of seats are provided for the first comers—the other passengers stand. As a rule, those who stand in fourth-class compartments far outnumber the fortunate few with seats.

First-class compartments correspond with our parlor cars; second-class cars are as comfortable as our best modern coaches; third-class accommodations are considerably worse than our poorest and oldest day coach, or perhaps a shade better than our colonist car. The seats in third-class cars are not upholstered. With four passengers per seat all occupants are crowded. We have nothing that compares with fourth-class. Very few passengers use first-class compartments.

Most of the well-to-do and tourists travel second-class. A traveler who wishes to economize may ride third-class for short distances without much discomfort, if the train is not crowded, but he must be in hard straits indeed to economize by riding in fourth-class cars. Nevertheless, as will be pointed out later, 46 out of every 100 passengers use fourth-class accommodations.

Train Service.—In speed of passenger trains Prussia is somewhat behind England and France. The fastest train in Prussia makes the run of 178 miles between Berlin and Hamburg at an average speed of 55.2 miles per hour. The next fastest train is between Berlin and Halle, 100 miles, at a speed of 54.9 miles per hour. There are several other through trains which average over 50 miles per hour, and the average schedule speed of all through trains is given in the official statistics as 40 miles per hour. With the exception of a few of our limited trains, and the Camden-Atlantic City trains, the Prussian speeds are equal to those of this country. There are several trains, for instance, which for similar distances and a similar number of stops, make somewhat better time than the five-hour limited trains between New York and Boston. The Prussian trains, too, are almost invariably on time.

We will now undertake a consideration of the traffic characteristics and first examine the statistics of train mileage, and passengers and tonnage handled. As already stated, the number of passengers handled in Prussia exceeds the total number handled in the United States. We are therefore prepared to find a very dense passenger train mileage per mile of road. Freight traffic is also dense in the industrial regions of western Prussia, but when averaged for all of Prussia the figures are not so impressive. A comparison of traffic and train mile density is shown in the following table:

PASSENGER MILES, TON MILES, TRAIN MILES AND OPERATING REVENUE PER MILE OF LINE, 1910

Item	Prussia-Hesse	Group 2	United States
Passenger miles per mile of line	693,921	314,187	138,169
Ton miles per mile of line	1,150,490	2,797,011	1,071,086
Operating revenue per mile of line	$22,144	$24,619	$11,553
Passenger train miles per mile of line	7,741	5,515[1]	2,787[1]
Freight train miles per mile of line	4,824	4,832[1]	2,286[1]
Total revenue train miles per mile of line	12,565	10,347	5,073
Average passengers per train mile	87	63	56
Average revenue tons per train mile	236	502	380

The significant facts in the above comparison are that in revenue passenger mile density the United States as a whole has only 21 per cent. of the Prussian density. Group 2, which has the greatest passenger traffic of any group in the United States, has 45 per cent. of the Prussian passenger density. In ton mile density, however, the United States is almost as much as Prussia, and group 2 exceeds Prussia in that respect by 140 per cent. The Prussian passenger trainload is considerably heavier than ours, but the majority of the passengers ride in the third and fourth-class cars, already described. In freight-trainload, however, Prussia is conspicuously low. Its average is less than half the trainload of group 2, and about two-thirds that of the whole United States.

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[1] Special train miles included in passenger; mixed train miles in freight.

Passenger Traffic and Rates.—The German statistics of traffic are available in great detail, and we are able to analyze the receipts and averages for each class of passenger and freight. To show the results for the passenger service, the following summary is inserted:

Division of Passenger Traffic, Prussia-Hesse, 1910

Class	Per cent. of passengers carried	Per cent. of passenger miles	Per cent. of passenger revenue	Average revenue per passenger	Average revenue per passenger mile	Average miles per passenger
First class	0.14	0.89	2.94	$2.65	2.89 cts.	92
Second class	9.66	11.00	18.56	0.25	1.49	16
Third class	43.66	39.51	41.65	0.12	0.93	13
Fourth class	45.51	44.59	35.09	0.10	0.69	14
Military	1.03	4.01	1.76	0.22	0.39	56
Total	100.0	100.0	100.0	0.13	0.88	14
Tickets sold at reduced rates—season tickets, workmen's, school tickets, etc. (included in above)	55.46	26.75	14.53	0.03	0.38	7

The preponderance of the third and fourth-class traffic, and the exceedingly small number of first-class passengers, are noticeable. The astonishingly low average passenger mile rate (8.8 mills) loses much of its value for purposes of comparison with this country because it includes such a relatively large number of passengers who travel in the inferior class compartments. The returns include also the traffic on passenger belt lines in Berlin and the electric railway between Hamburg and Altona. Both of these lines carry a heavy traffic, which is essentially the same as is handled by the subways and elevated railways of New York, Chicago or Boston.

In second-class compartments, which come nearest to our day coaches, the Prussian average revenue was 1.49 cts. per mile. Our average in the same year for all passenger traffic was 1.938 cts. The Prussian first-class corresponds to our parlor cars. Their average receipts for that class were 2.89 cts. per mile, which is substantially above our average, even when the Pullman car fare is added. For instance, the regular fare from New York to Boston is $4.75. Add $1.00 for parlor car seat and we have an average rate of 2.47 cts. per mile.

In passing, attention should be called to the fact that there is no free baggage allowance in Germany. Passengers may take a generous amount of hand baggage with them in the compartments, but trunks and other similar baggage must be registered and transported in the baggage car. The baggage tariff is on the zone principle. For example, the charge for the first zone (1 to 15.5 miles) runs from 5 cts. for 44 lb., to 14 cts. for 165 lb. For the fourth zone (95 to 126 miles) the charges are 12 cts. and 71 cts. respectively. For the sixth zone (158 to 186 miles) the charges are 12 cts. and $1.07. To illustrate further, by again using the New

York and Boston journey, the additional cost of a trunk weighing 150 lb. would, under the Prussian tariff, be $1.43, which is equivalent to adding 0.61 ct. per mile to the price of the ticket.

The Prussian statistics show, however, that relatively few passengers carry other than hand baggage. Altogether in 1910, the railways transported 820,000 tons of baggage. This is an average of 1½ lb. per passenger. The revenue from baggage was $4,370,000, or 27 cts. per 100 lb. The average distance carried was 65 miles. Each 100 lb. of baggage, therefore, cost the traveler 41 cts. for each 100 miles transported. Baggage charges made up 3 per cent. of the total poassenger revenue.

Before leaving the passenger service, mention should be made of the practice of selling "*bahnsteig*" (platform) tickets which permit the friends of incoming and outgoing passengers to meet or part with them on the station platform at the car door. These tickets, which cost 10 pfennig (2.4 cts.) are procured through slot machines. They are punched by the gateman when the holders pass through the gate to the platform, and are collected when they leave the platform. In 1910, 31,000,000 of such tickets were sold (85,000 per day) and they yielded a revenue of $735,000. This, of course, is clear profit.

The designers of railway stations in Europe seem to have realized long before we did in this country, and it is a question whether we have realized it yet, that the passenger station's design ought of necessity fit in with the architectural character of the city. In Europe, and particularly is this true of Germany, there exists a "city sense," so-called, which demands that the buildings on a street harmonize, that the city be an architectural whole and that the railway station as a gateway be a proper unit of the whole. It is far oftener the rule there for the station to be centrally placed with a plaza before it and streets radiating from it to all parts of the city.

European stations, and those on the continent perhaps more than those in England, differ also from our own in that it is the rule rather than the exception for incoming traffic to be separated from outgoing. This prevents congestion but it has its bad points. The story is told, for instance, of the passenger who, arriving in Brussels and desiring almost immediately to continue his journey toward France, was obliged to leave the station on the arrival side, pass completely around the building through the streets with several pieces of baggage, re-enter the station on the departure side to reach a train only a few feet away from the one he had just left.

It will perhaps be worth while to say a few words about some of the important foreign stations.

The newly reconstructed Waterloo Station of the London & South-Western in London covers 16 acres of ground, and is divided into three portions: the main section with four platforms opened in 1848; the south station with two platforms opened in 1878 and the north station with six platforms opened in 1885. The average daily traffic is 966 trains in and out and 80,000 passengers. On busy days 2,500 train, draft and engine movements are made.

The Liverpool Street Station in London is the busiest station in Great Britain and one of the two busiest in the world, being second only to the Gare Saint Lazare in Paris. It has handled a maximum of 200,000 patrons in a day. H. W. Thornton, formerly general manager of the Long Island, and now general manager of the Great Eastern of England recently made the statement that:

> "With one exception, and that is the St. Lazare station in Paris, there are more trains in and out of the Liverpool Street station, which is the London terminus of the Great Eastern system, than any other railway station in the world. The Great Eastern serves territory generally known as East Anglia, but there are other roads also touching this section, which in a sense gives the Great Eastern some competition, though upon the whole, it has the eastern counties to itself. From 6 o'clock in the morning to 9:30, also of the morning, there are 278 trains arriving in the Liverpool Street station, and the number of passengers alighting therefrom during these three hours and a half is about 75,000. During the entire 24 hours there are almost 700 trains arriving in the station, and about the same number departing therefrom, making a grand total of trains in and out of the station every 24 hours of about 1,400. So you see it requires the highest efficiency in the staff and the working force of the road to care for so many trains, so close to one another, to insure safety and promptness."

The Waverly Station in Edinburgh, Scotland, is a part through and part head station. Its cost including the property on which it was built was $7,500,000. The cost of operating it exceeds $165,000 a year. There are four approach tracks in each end; two through station tracks on each side, besides eight platform terminal tracks in the south and seven in the north end. The average daily train arrivals and departures are 630 of which 40 occur during the busiest hour.

The busiest station in the world is undoubtedly the Gare Saint Lazare in Paris. In summer time it is the custom for people to go out of Paris Saturdays and Sundays in large numbers. On these days the facilities of the Saint Lazare station are taxed to the utmost. To facilitate the rapid handling of traffic in the station, trains arriving are not moved but the locomotive is uncoupled, turned and moved to an adjoining track by a combined traverse and turntable. After coaling and watering it returns and backs onto an outgoing train.

The Saint Lazare station is operated by the Western Railway. It is partly at street level and partly above. It contains 31 tracks—27 for passenger trains and four for locomotives and other service. About 1,300 ft. from the station the tracks converge into six entrance tracks and pass through a tunnel, about 1,000 ft. long and then through a deep cut. There are about 1,200 daily train arrivals and departures and the maximum traffic totals 250,000 passengers a day. The plant covers 27 acres. Fig.

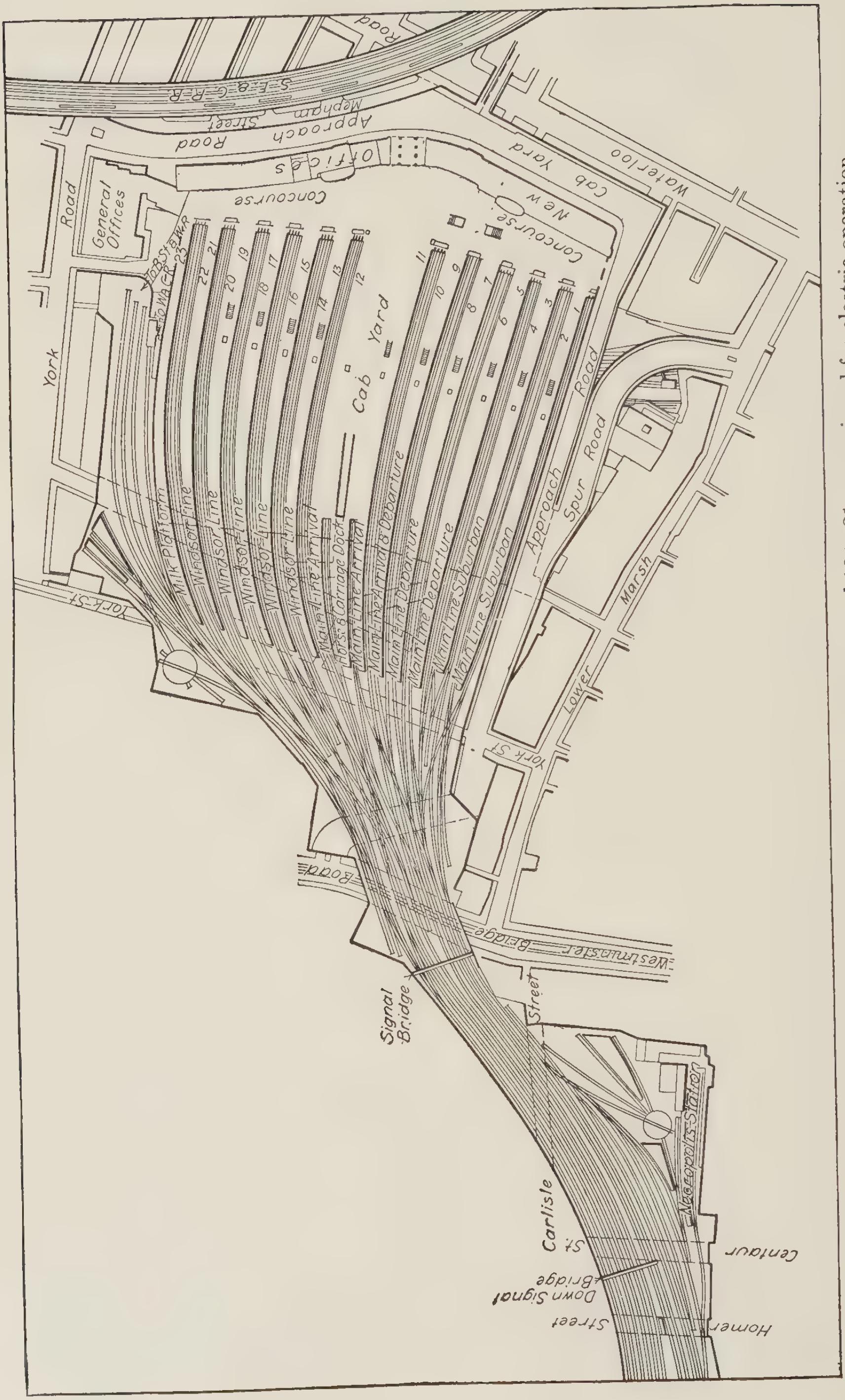

FIG. 176.—General plan of Waterloo Station. Tracks 1 to 6 and 16 to 21 are equipped for electric operation.

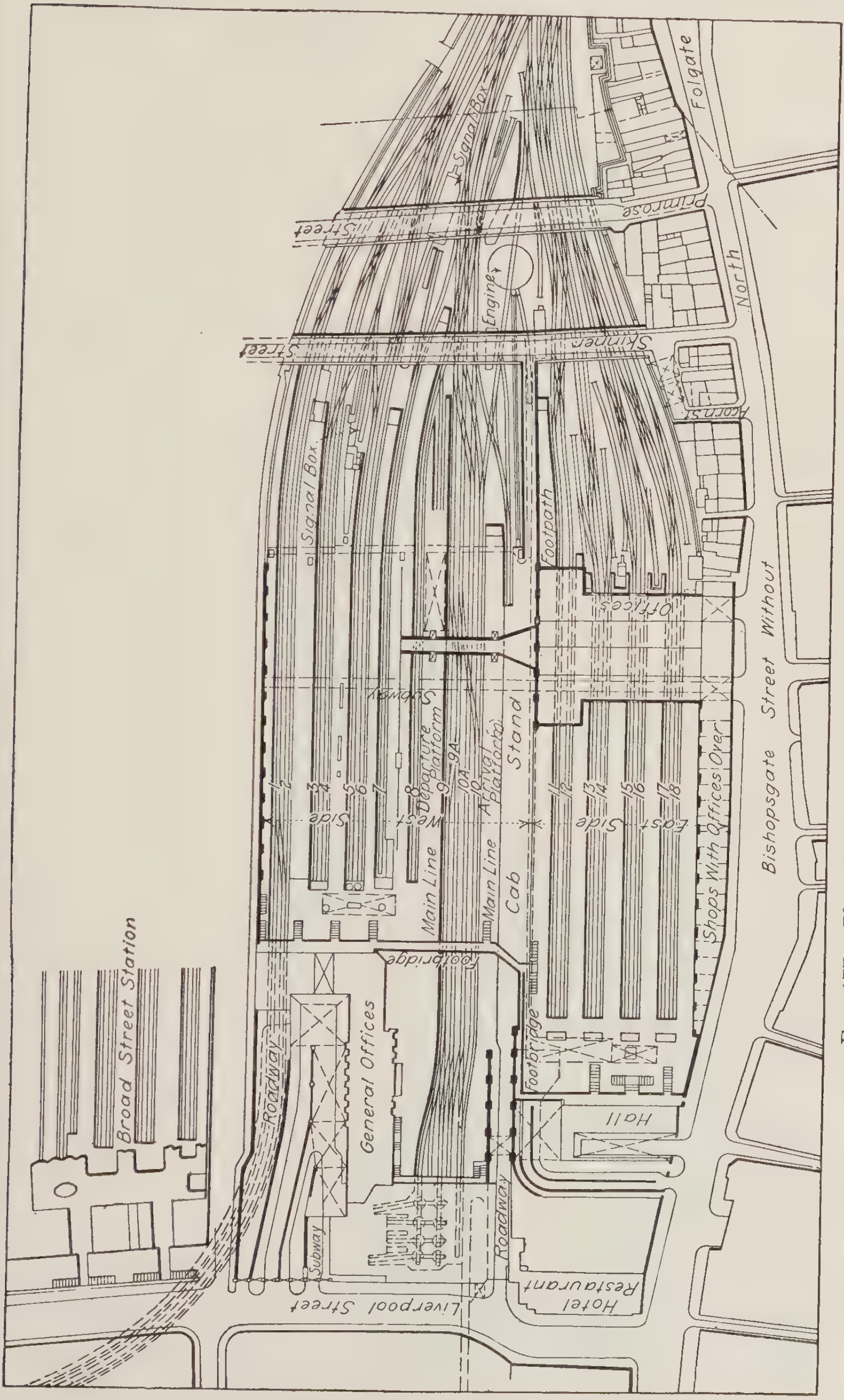

FIG. 177.—Plan of Liverpool Street Station, the busiest in London.

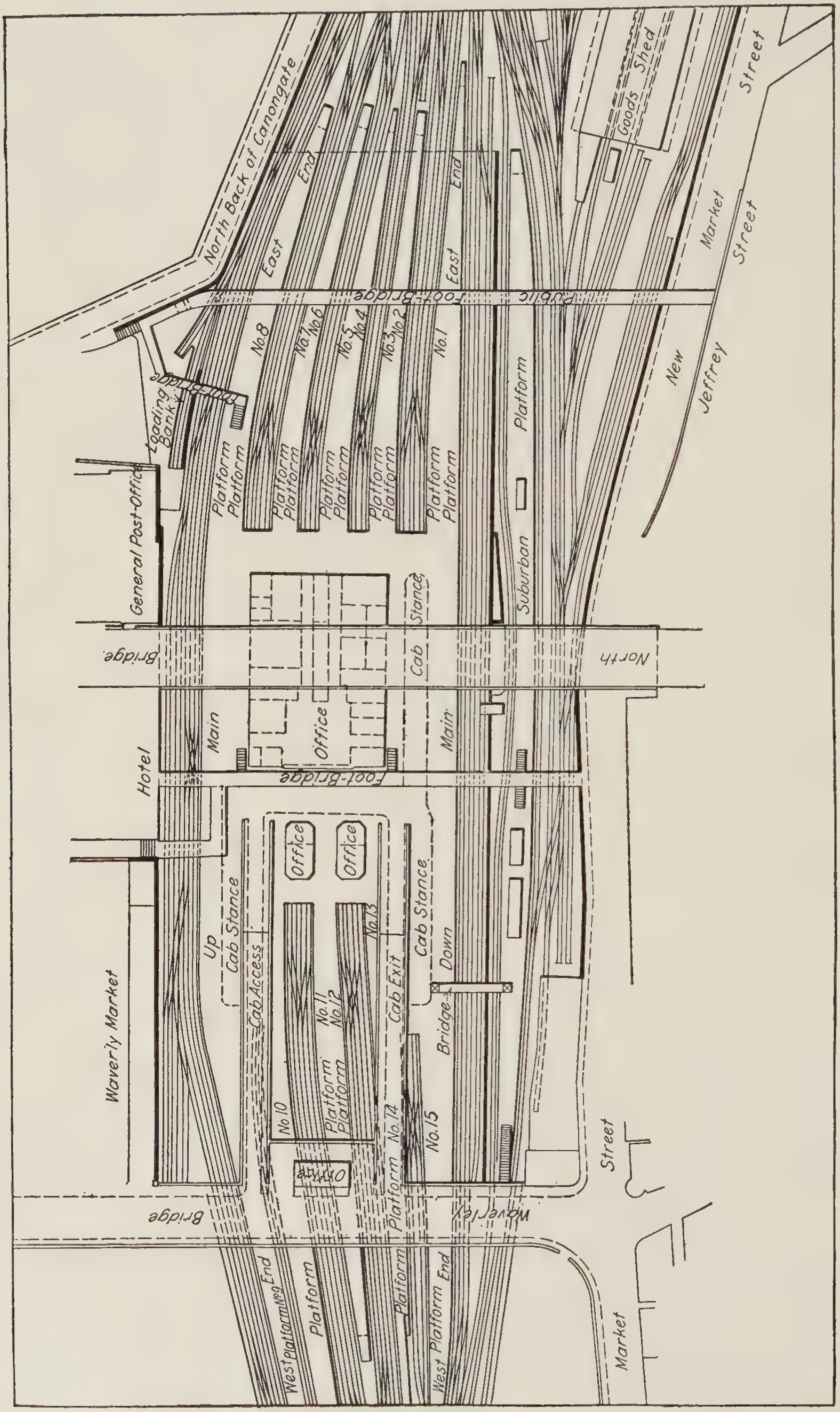

FIG. 178.—Waverley Station, Edinburgh.

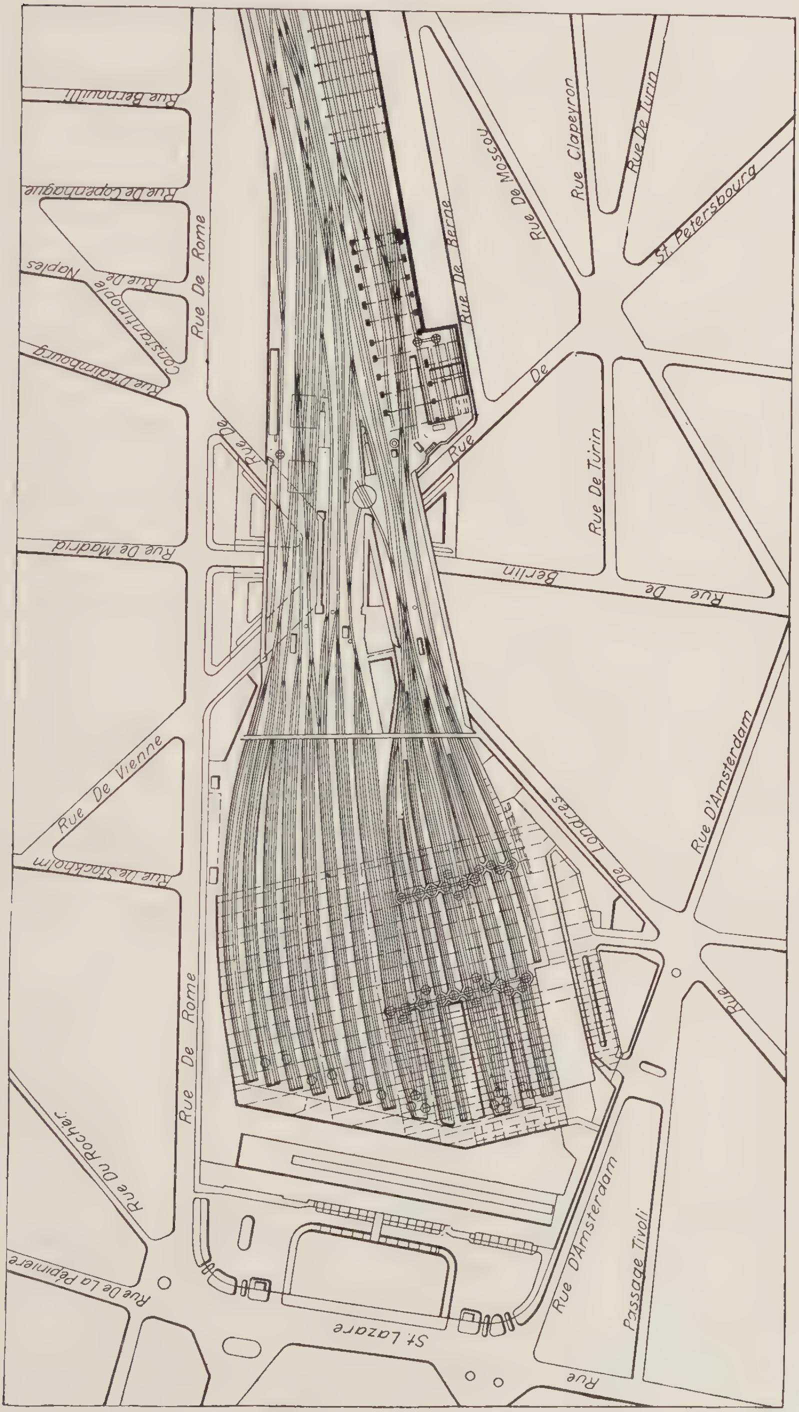

FIG. 179.—Plan of Gare St. Lazare, the busiest station in the world.

180 is a section of the Saint Lazare combined traverse and turntable which is typical of many used on the continent.

In Fig. 181 is shown the inclined baggage carrier on which the baggage

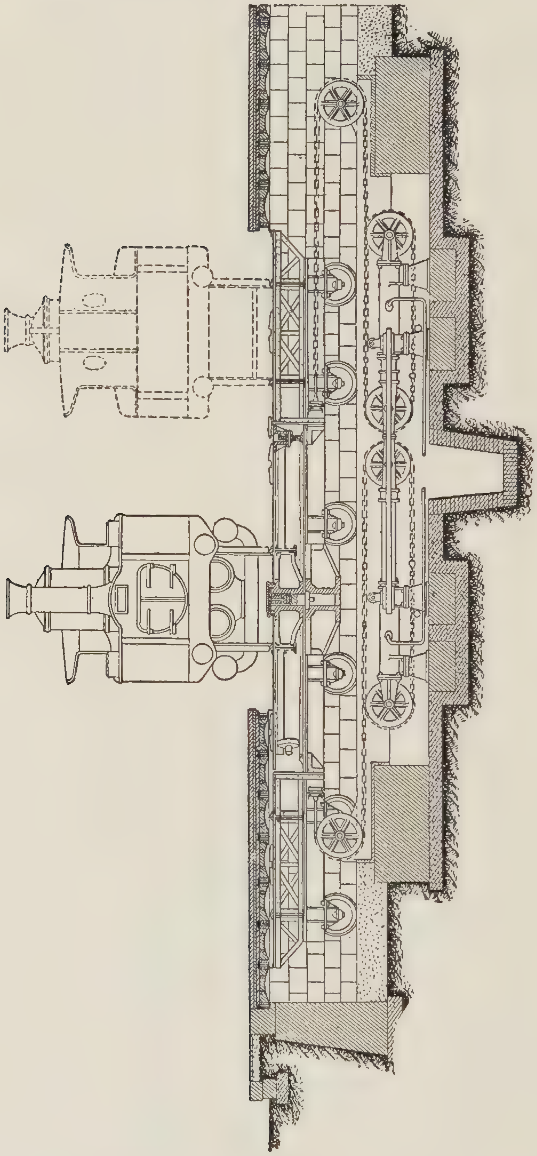

FIG. 180.—Traverse-turntable for locomotives, Gare St. Lazare.

after it is registered is raised to the track level on small trucks. This is done by means of movable inclined lifts hauled up by endless chains worked by hydraulic power.

The Leipsic station, a view of which is shown in Fig. 173, is the largest (but not the busiest) in Europe. It has been under construction since 1907 and has just been completed. The station has 26 tracks. The main building covers an area of 172,000 sq. ft. The cost of the station was $33,000,000, of which $15,000,000 was borne by Saxony, $13,000,000 by Prussia, $4,000,000 by the city of Leipsic, and $1,000,000 by the Imperial Post-office Department.

The Frankfort-on-the-Main station is owned and operated by the Prussian-Hessian State Railways. The station is really a street level station, the entire area in front and on the sides having been raised and embellished with grass plots, parks and an ample approach area. To prevent the tracks from crossing one another at grade those lines coming in laterally are elevated above those entering directly. The station's train shed measures 551 ft. by 610 ft. and has an area of 336,110 sq. ft. There are 18 tracks. Fig. 175 shows a view of the station.

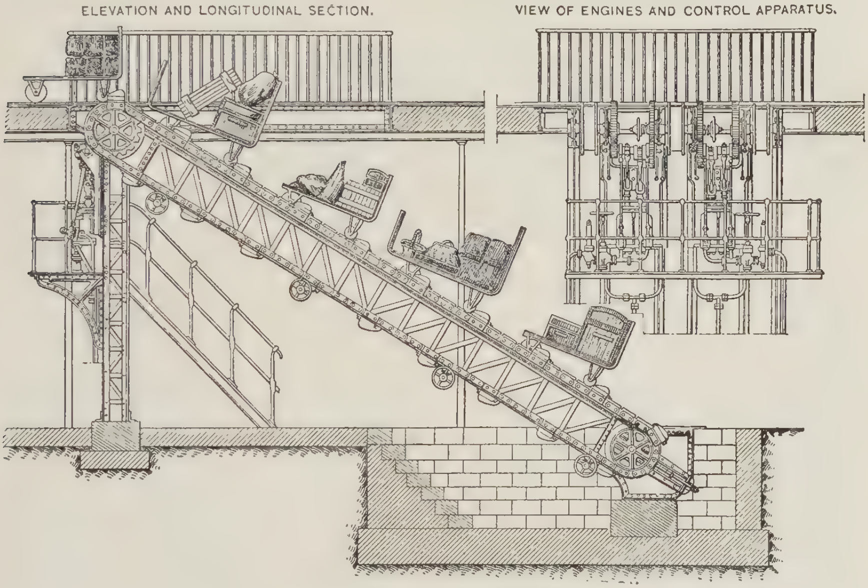
ELEVATION AND LONGITUDINAL SECTION.
VIEW OF ENGINES AND CONTROL APPARATUS.

Fig. 181.—Inclined baggage lift, St. Lazare Station.

The North Station in Hanover, Germany, is occupied by four important divisions of the State Railways. Hanover is an important city located on through lines running from Frankfort to Hamburg, Bremen, Cologne and Berlin. The head house of this station is 92 ft. by 566 ft.; the train shed, 280 ft. by 566 ft., and there are nine tracks. The total cost was $5,315,000.

The interesting features of the new Havana (Cuba) passenger station are the architectural and climatic adaptations. The station is the finest and most modern in Cuba, and, like all buildings in Havana, in keeping with its surroundings. The building itself is 70 ft. by 240 ft. and has three stories and an attic. The main waiting room is 72 ft. by 128 ft. and extends all the way up to the roof, having a clear height of some 60 ft. It is finished in Italian marble with mosaic floor and has adjoining it the usual men and women's retiring rooms and toilets. The station has a café 40 ft. by 52 ft., which has a high wainscot of elaborate Spanish tiles, and

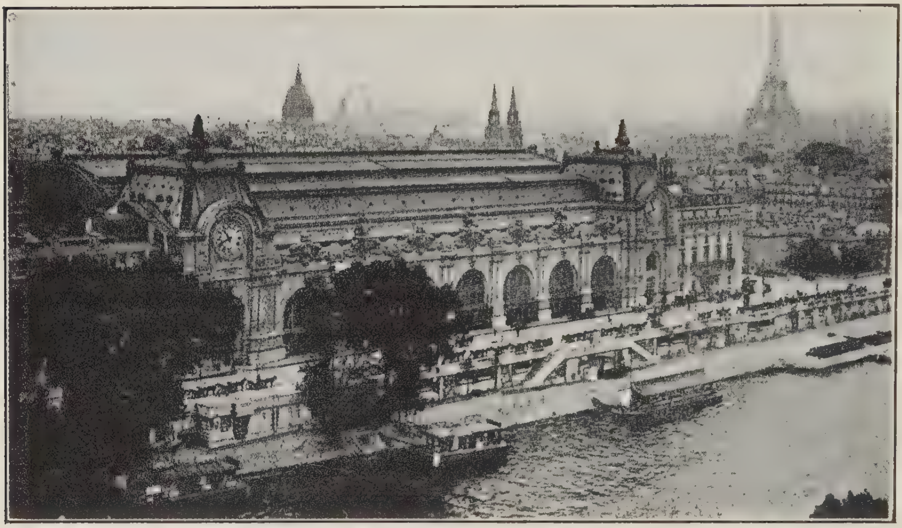
FIG. 187.—Gare d'Orsay, Paris.

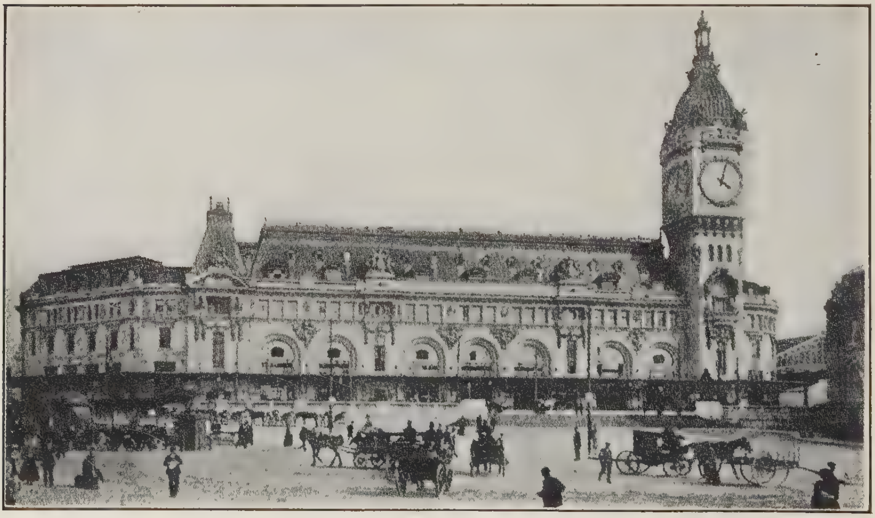
FIG. 183.—Gare de Lyon, Paris.

a marble bar. The café is entirely open to the street on two sides with a sufficient sidewalk to allow placing café tables there, as is done in European cafés. In addition to the large waiting room, there is a concourse 50 ft. by 200 ft., provided with seats to take care of a large part of the traffic.

On the second and third floors are the offices of the United Railways of Havana.

The exterior of the building is in the style of Spanish Renaissance, and is built of American terra cotta. The distinctive features of the front elevation are the twin towers, arising 130 ft. above the street. These towers contain water tanks of 20,000 gal. capacity, for fire and storage purposes. The towers also form an excellent point of observation for visitors to Havana. The roof is covered with red Spanish tile, which is used freely on Cuban buildings.

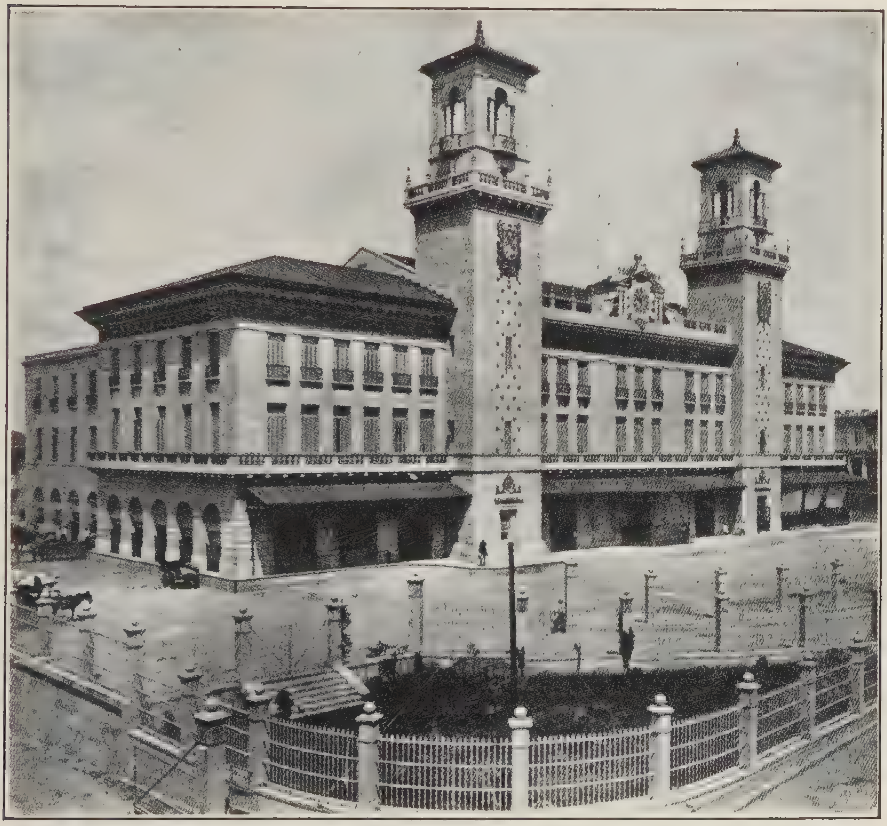

Fig. 184.—Central Station, Havana.

A peculiar feature of the building is that there is no glass in the windows, with the exception of a small panel in the shutters, and also panels in the toilet room windows. Double sets of shutters have been provided for all the windows; the exterior set with fixed louvres, to be closed in the case of an ordinary rain storm, and an interior set with reinforcing bars and extra heavy bolts to be used when the famous Cuban hurricanes occur. The light penetrates so far into the buildings in Cuba, that even with all the shutters closed the rooms seem as bright as in an ordinary American building with everything open. Two of the principal problems in Cuban construction are keeping the light out and the roof on.

The Egmore Station in Madras on the east coast of India is a terminus of the Southern Indian Railway. The structure was completed in June, 1908. It is a combined railway station and hotel and one of the most beautiful buildings in the city. It is patterned after the Moghul style of architecture and is built of brick with trimmings of granite and sandstone. Several towers, a number of semicircular domes and the intricate stone carving, fantastic stone brackets, drip stones and rich friezes of its exterior at once attract attention.

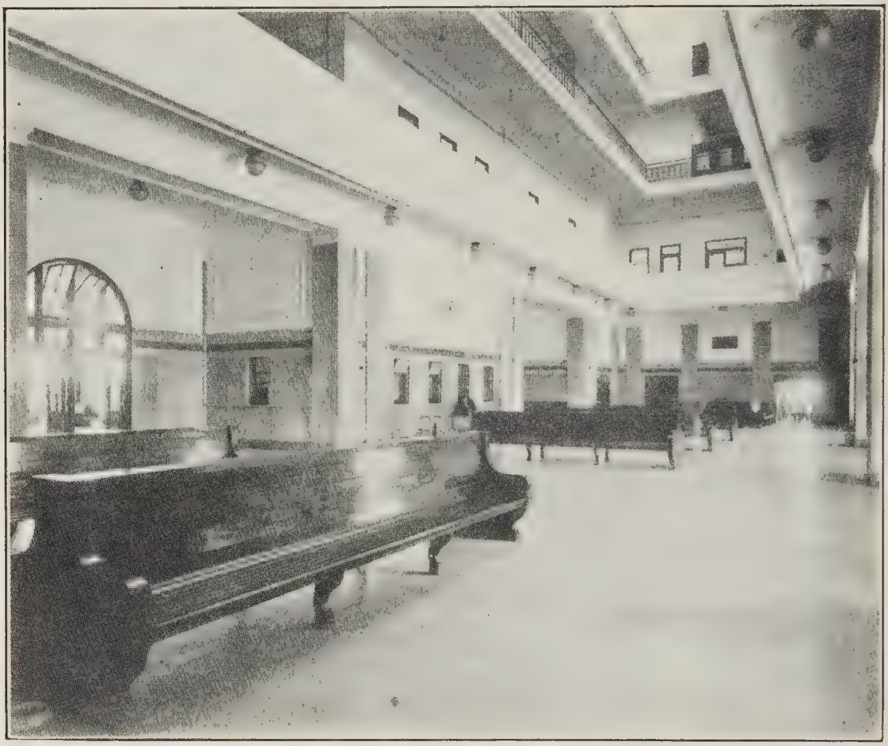

Fig. 185.—Interior of Central Station, Havana.

The main building is 330 ft. long, 71 ft. wide and two stories high. The lower floor, at platform level, is occupied by refreshment rooms,

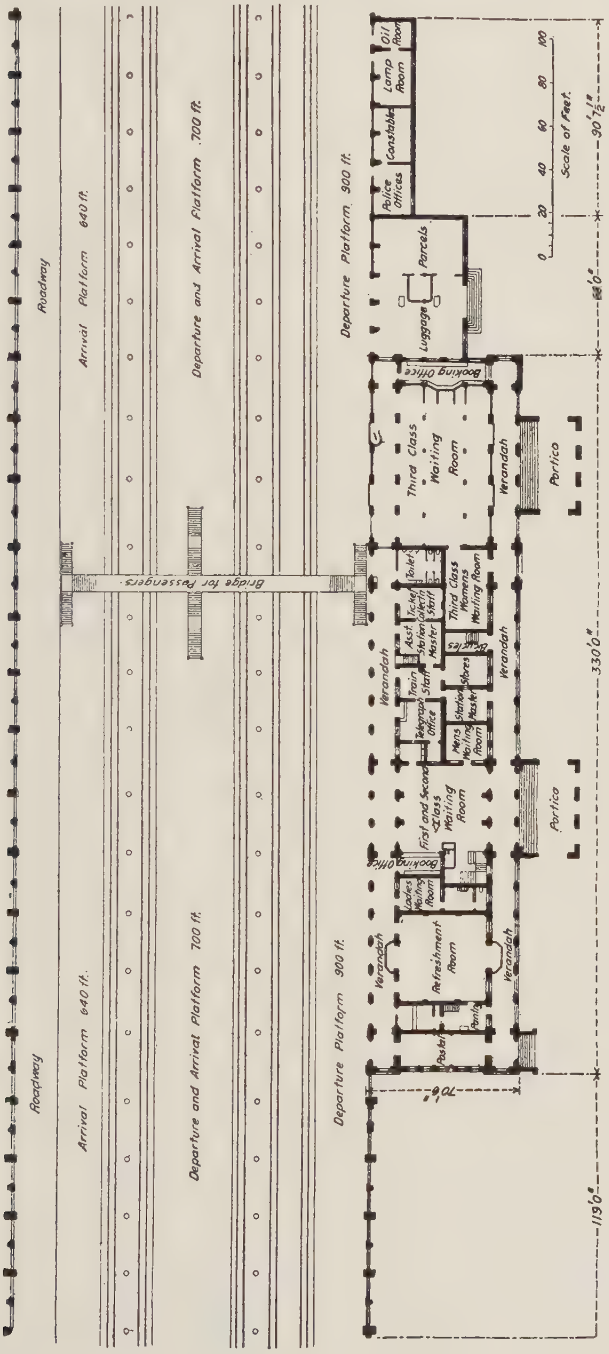

FIG. 186.—Plan of Egmore Station, Madras, India.

waiting rooms, the usual offices for the station staff, and the post office. At the east end there is a single-story extension, 67 ft. by 45 ft., in which there is a large luggage and parcels office, and beyond this another single-story building, 90 ft. by 20 ft., for the government railway police and for lamp and storerooms.

There are two waiting rooms, one for first- and second-class passengers, and another for third-class patrons. The former is 40 ft. by 37 ft. in size. The third-class waiting room is at the opposite end of the station and is separated from the first- and second-class waiting room by the station offices. It is 76 ft. by 52 ft. in size, and connected with it there is a large waiting room for native ladies. There are well-furnished ladies' and gentlemen's waiting rooms for first- and second-class passengers, and a large dining and refreshment room, 40 ft. by 40 ft., with a buffet opening on to the platform, where light refreshments can be had. At the east end on the upper floor there is an office for the district traffic superintendent, and at the west end a kitchen, the space in between being occupied by 13 bedrooms, six bathrooms with lavatories, and a sitting room.

Outside of the building there are three departure and arrival platforms 895 ft., 700 ft. and 650 ft. long, respectively, connected by an iron footbridge, and covered over for a length of 602 ft. by a three-span steel plate roof with glazed gable ends.

The station and platforms are lighted throughout by electricity, and the rooms are fully equipped with electric fans.

CHAPTER XVII

ELECTRIFICATION

In the preceding chapters attention has been mainly confined to the terminal facilities required for trains handled by steam locomotives. Within the past few years, however, steam locomotives have been superseded, in a few instances, by locomotives driven by the new source of motive power—electricity. This new source received its early impetus and development, as applied to transportation purposes, in its use in city and interurban trolley systems, where it quickly proved its superiority. Its advance in the traction field has been rapid and has continued steadily until now the trolley car is almost without serious rival. Engineers, meanwhile, have gradually discovered and understood electricity's underlying laws and have also ascertained its possibilities of wider application, as for example, to both elevated and underground railways such as the Chicago, New York, Philadelphia and Boston elevated lines or the subways of London, Paris, New York and Boston, extensive and highly congested arteries of travel, calling for heavy trains at high speeds.

Electricity met the new and onerous conditions of this service so readily and was found to be so adaptable and flexible to a diversity of requirements that there is little reason for surprise that its scope has been further extended. It has now shown the possibility of its practicable application to every sort of railway transportation, and is handling suburban, interurban, trunk line, passenger, freight, switching and mountain grade services with considerable degree of success.

It must, however, be remembered that electric operation of trunk-line railroads is still in its infancy; that the percentage of railroad mileage operated by electricity is very small, and that it has by no means demonstrated without question that it is more reliable and efficient than steam operation. It is not within the province of a work of this character to discuss fully the various aspects of electrification and its results. It is not the intention to attempt to prove that electric operation is the success which is claimed for it by its supporters or is the failure as charged by its opponents. That question cannot at this early stage be answered, either as applied to specific railroads or as a general proposition. It is the intention merely to point out the general characteristics of electric operation, to describe briefly the chief systems of electrification, and to discuss in a general way the advantages and disadvantages, the points of strength and weakness of this newest system of railroad traction.

In steam railway operation each train has its own source of power, which bears no relation to the propulsion of the other trains on the line. In electric railway operation every train draws its power from one or more centrally located power houses. The power is transmitted from the power house to the trains either by means of a third-rail which carries the current to the locomotive and the third-rail shoes through which the power passes into the locomotive, or by means of an overhead sytem of wires, and the trolley or pantagraph through which the current passes to the electric apparatus in the locomotive. The third-rail system is used only when the electric power is of low voltage. When the power is of high potential it is obvious that for reasons of safety if no other the overhead system must be used.

Steam trains are hauled by locomotives only. Electric trains may be propelled either by electric locomotives or by motor cars. The latter may be of two kinds, those with motors on every car and those made up partly of motors and partly of trailer cars. They are usually arranged on what is called the "multiple unit system" wherein each car is a unit so arranged that a whole train consisting of any reasonable number and arrangement of motors and trailers may be controlled as a whole from either end of any motor or trailer car. This arrangement is convenient and flexible, particularly in congested terminals, and naturally reduces the number of train movements.

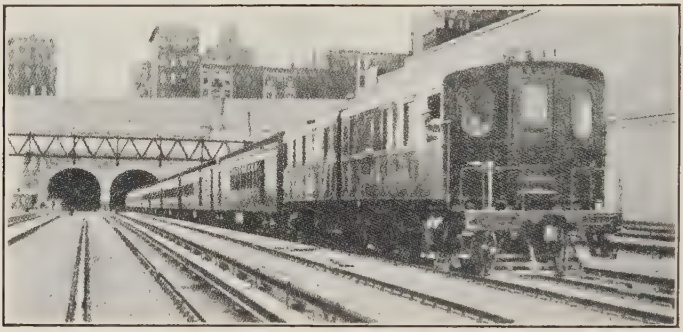

Fig. 187.—Pennsylvania train coming into terminal in New York City.

Not only can two motor cars work as a unit and be operated by one engineman, but two or more electric locomotives coupled together can be operated by a single engine crew from one controller. In steam operation an engine crew is required for each engine. If, however, the second electric engine is in the middle or on the end of the train a crew is required for each engine.

Since each steam train has its own power house it must furnish that plant with coal and water, the ashes must be disposed of and the fireboxes cleaned. Since the electric locomotive does not have its power house, but draws its current from a central plant, there is no coaling or watering necessary. An electric locomotive, therefore, can work continuously for 24 hours a day unless it is heavily loaded. If the latter is the case, it must be given an opportunity to become cool again after its run.

There are three separate and distinct systems of electric operation: (1) the direct-current system; (2) the single-phase system; and (3) the three-phase system. All these systems have points of similarity. In each case power is generated at one or more central power houses. The difference occurs in the kind of electricity used on the trains and in the methods of transmitting this electricity from the power house to the train.

Each of these systems has its distinct advantages and disadvantages. It cannot be said that any one of them is the best system of electric railroad operation. The direct-current system is the oldest and the most highly developed. It is used not only in street railway operation but also in the New York terminal electric operation of the New York Central and Pennsylvania Railroads. The other two systems are of much more recent development but have demonstrated certain advantages when applied to certain conditions of traffic. It should be borne in mind, therefore, that the electric engineer must study each problem with a view to ascertaining which of these systems best suits the traffic and operating conditions of the railroad contemplating electrification. The system of electrification must conform to the railroad's needs; the reverse is impossible. What is said, therefore, concerning these systems of electric operation should not be taken as an argument for or against any system but rather as a general indication of the recognized advantages and disadvantages of each.

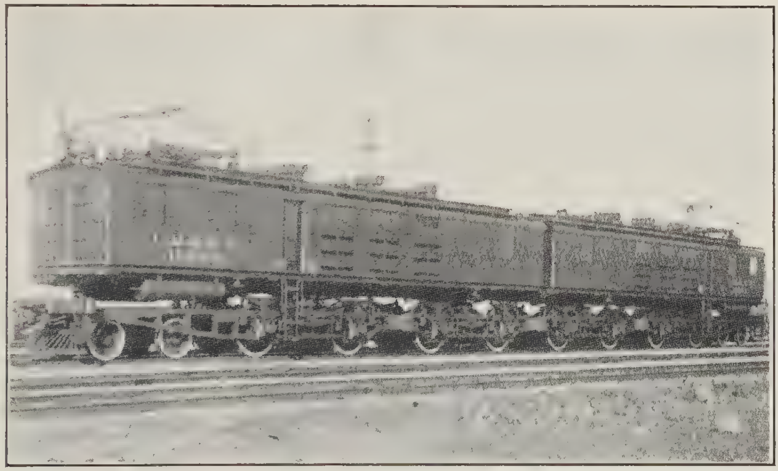

Fig. 188.—Locomotive used on St. Paul's electrified line.

The Direct-current System.—In the direct-current system power is generated at a central power house at high pressure, and transmitted at high pressure along separate transmission wires in each direction along the right of way, feeding what are called substations, a number of which are situated at suitable points on the electrified system. The electricity when it enters the substation is alternating in character and of high pressure, and therefore, being of high pressure, needs to be small in amount. The pressure then has to be reduced to that at which it can safely be used on the trains, and in the process the electrical current is automatically increased in amount so that the entire change is made from small amount at high pressure to large amount at low pressure. This operation requires the use of transformers. After the pressure has been reduced it is still alternating in character and before it can be used on the direct current train, it has to be changed into direct current. This requires rotating machines known as rotary converters, or motor generators, and it is obvious, therefore, that each substation requires one or more attendants operating three shifts per day to care for such machinery and other apparatus. From the substation this current—direct current—is led out by heavy cables to either a third rail or overhead wire, depending on the method of current collection used. If a third rail is used, it is usually of special composition, being of soft iron but of high conductivity, 7 sq. in. of rail usually being equivalent to 1 sq. in. of copper in conductivity. The standard pressure for direct current is approximately 600 volts, this being the highest pressure it is usually considered safe to put into a rail situated close to the tracks. The above description applies in almost every particular to the New York Central, the Brooklyn Rapid Transit,

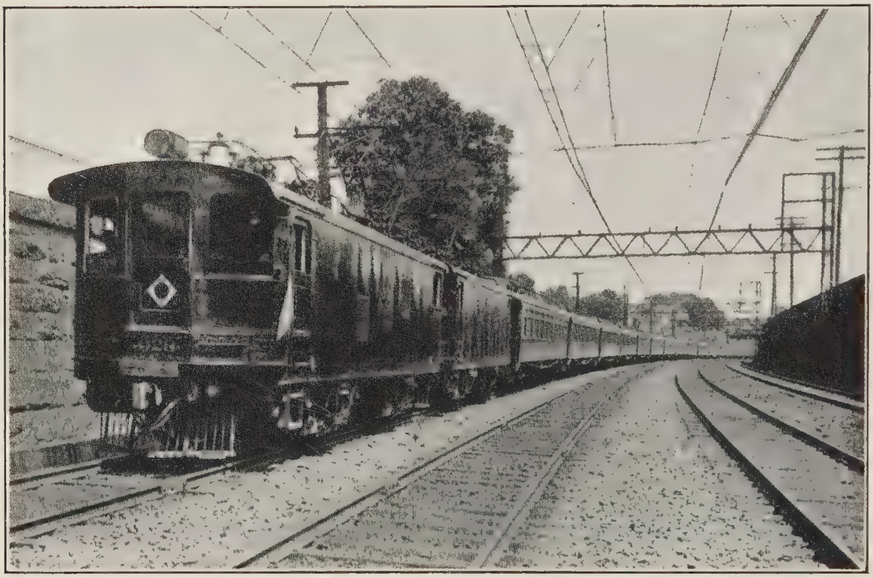

Fig. 189.—Heavy passenger train, New Haven.

the West Jersey & Seashore, the Chicago Elevated, the London underground and many other lines; and this was the first system of electricity adopted. Experience has shown that 600 volts is too low; that at this voltage the losses in the rails and between the substations are excessive; that the loss in efficiency due to the many transformations in the substations is costly; and that, if direct current is to be used at all, it will be necessary in future installations to use high voltages.[1] High voltages on the third-rail system are dangerous; so in recent installations where direct current is used the pressure has been raised to 1,200 volts, in several cases to 2,400 volts, and in one case to 3,600 volts; and in each case an overhead wire has been used.

It will be seen that the necessity for substations not only brings in an additional burden of fixed charges due to the extra investment required, but also adds to the expense of operation of the electric system to the extent of the cost of maintenance and operation of such substations. These two factors, taken with the loss in efficiency which takes place in each link of the chain, namely, in the transformers and the rotating machinery, and in the rail or overhead wire, constitute a factor, in the opinion of many, which largely offsets certain other advantages which are possible when direct current is used. With regard to these advantages it may be said that the use of direct current permits the use of lighter rolling stock than is possible with either the single-phase or three-phase systems. This question of rolling stock weight is of considerable importance, particularly if the use of motor car trains is involved. The question of weight, however, becomes one of relatively small importance if the trains are locomotive-hauled, for it is obvious, for instance, that a difference of 15 or 20 per cent. in locomotive weights is reduced to a factor of only 2 or 3 per cent. when equated with the total weight of the train. It is

Fig. 190.—Twentieth Century Limited, New York Central.

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[1] The system recently installed on the lines of the Chicago, Milwaukee & St. Paul uses 3,000 volts d. c.

necessary in forming opinion as to the suitability of alternating-current or direct-current systems for any installation to balance carefully the advantage in weight resulting with the direct-current system against the advantage of overall efficiency which the simpler and more flexible single-phase system possesses.

Single-phase System.—With the single-phase system alternating current is generated at a central power house, usually at 11,000 volts, and remains alternating current on all the circuits between the power house and locomotive and back again. In its simplest form it may leave the power house, for example, as high pressure alternating current at 11,000 volts and feed directly the overhead wire above the track, being collected from this wire by pantagraph shoes and reduced in pressure on the locomotive itself. This is the simplest electrification system and the one having the smallest number of links. It is not, however, suitable for an extensive electrification. In such cases the pressure is raised at the power house to a higher voltage than 11,000 volts and transmitted at this high pressure to open-air type transforming stations called alternating-current substations. At these substations it is reduced in pressure to 11,000 volts and fed to the overhead wire as previously described. It can be seen that even in its most comprehensive form the single-phase system involves the use of no substation except the open-air transformer which requires no attendance; it involves the use of no rotating machinery between power house and rolling stock and, therefore, suffers little loss in efficiency on that account. On the other hand, as pointed out, it is necessary to transform from the high pressure to a safe working pressure inside the rolling stock itself. This makes it necessary that each locomotive carry a transformer with resulting increase in weight. The considerations of weight as outlined for the direct-current system apply here equally.[1]

The alternating-current system compares disadvantageously with the direct-current system in some ways but advantageously in others. Summing up its bad points as compared with the direct current it is found that the rolling stock is slightly heavier and somewhat less efficient and is higher than equivalent direct-current rolling stock in first cost. The above in some measure may arise from the fact that while the direct-current apparatus has been developing 15 to 20 years and is now largely standardized, the alternating-current apparatus is a growth of the last seven or eight years and suffers the usual disadvantages of the pioneer. On the other hand, the alternating-current system shows some marked advantages, notably in its transmission efficiency, both in the primary transmission circuit and in the trolley circuits. In a typical case it was found that the overall efficiency of a direct-current system from power house to drawbar was 54.5 per cent. while for alternating current it was 67 per cent., a difference of 13 per cent. A difference of 13 per cent. in efficiency represents a difference in power requirements of 13 per cent., which is equivalent to stating that in spite of the lighter trains which the direct-current system would make possible, the power house for the direct-current proposition had to be of 13 per cent. greater capacity and supply throughout the year 13 per cent. more energy than the generating plant of the alternating-current installation. The reason can be plainly seen to lie in losses in the transforming and rotating apparatus in the direct-current substations.

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[1] The Norfolk & Western in its electrification is transmitting by three-phase 44,000 volts, and would have used 22,000 volts in its contact wires but for limited clearance in tunnels.

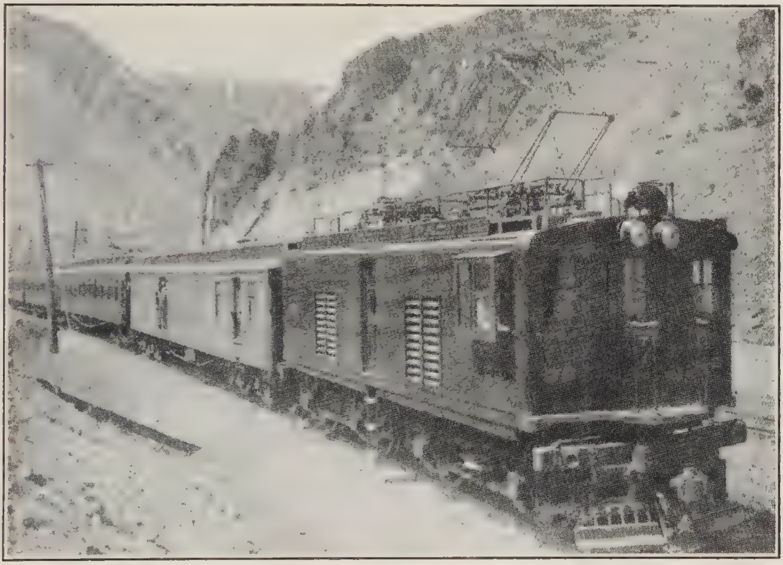

Fig. 191.—Passenger train, Butte, Anaconda & Pacific.

It has been stated in the foregoing that alternating-current rolling stock costs more than direct-current rolling stock. On the other hand, direct-current substations cost much more than alternating-current substations, other parts of the installation remaining about the same in each case.

A great point of superiority claimed for the alternating-current system is its flexibility as regards speed. With the direct-current system there are usually only three speeds at which it is economical to run. With an alternating-current system every speed is an economical running speed, and where the traffic requirements are varied this flexibility in speed control is a factor of practical importance.

Those responsible for recommending a system of electrification to railroad executives are faced with much the same responsibility as was the case 50 years ago when engineers had to decide whether they would build their tracks to narrow or wide gage. It is important that in the future, rolling stock from adjacent roads should be able to operate interchangeably. Experiments are being made to determine the practicability of the mercury arc rectifiers by which it is hoped that direct-current equipment can collect from an overhead wire supplying alternating-current and still operate as direct-current motors, although they have collected alternating current. In other words, direct-current rolling stock can operate from alternating-current wire along with alternating-current stock. The reverse of this, however, is not true; alternating-current rolling stock cannot collect direct-current from an overhead wire or third rail and operate, except with the introduction of extreme complications, involving great possibility of breakdown and large maintenance expense.

The Three-phase System.—The three-phase system is very little used, there being only one small installation in America. Several large installations, however, are in operation in Italy upon the mountain grades. The three-phase system in fact has found its chief field in mountain grade work, largely because it is possible by means of it to obtain a recuperation of energy on descending grades. That is to say, it is possible to make trains on descending grades send energy back into the overhead wires, which energy can be utilized to haul trains up the ascending grades. It differs from the single-phase system in that it involves the use of two overhead wires per track, which leads to much complication at junctions and switching points. It is, therefore, not regarded favorably except for special conditions, particularly because in cases where it is required recuperation is equally possible with a single-phase system, and can even be obtained in a direct-current system although with greater difficulty.

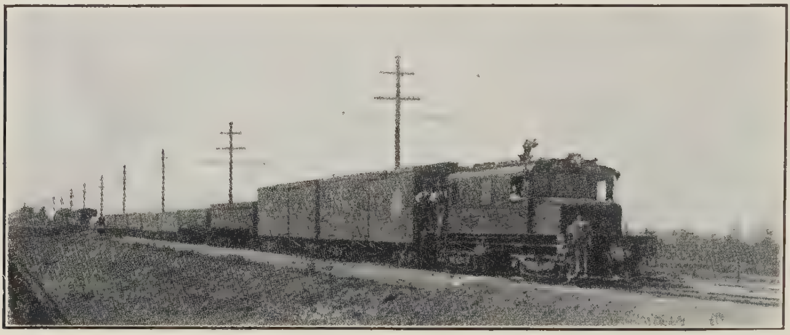

Fig. 192.—Freight train on Pacific Electric.

Whether the system of electric operation used is the single-phase alternating-current, the direct-current, or the three-phase, there are certain well-defined advantages and disadvantages which apply to all.

The benefits of electric operation as compared with steam, or claimed by the electrical engineers and other supporters of electrification, may be divided into four classes: (1) freedom from smoke; (2) greater engine efficiency; (3) elimination of coaling, watering, etc.; (4) reduced operating costs. The disadvantages claimed by the opponents of electrification may also be divided into four groups: (1) the heavy capital outlay required; (2) the additional danger due to high voltage lines; (3) additional opportunity for delays to trains; (4) higher operating costs.

It cannot be denied that the operation of trains by electric power is a benefit to the traveling public and to those near the right of way in that the smoke nuisance is entirely eliminated. This advantage is of far greater importance when the railroads enter large cities through tunnels. Steam operation in tunnels is at least to be avoided. because of the danger of collisions in a smoke-obscured subway. By the elimination of smoke it becomes possible to utilize much of the terminal which formerly had to be sacrificed. The great train shed can be entirely done away with and above the concourse where the trains arrive and depart offices can be built. In a large city where real estate values are high, this ability to utilize almost the entire land on which the terminal is situated, is an advantage of no small significance.

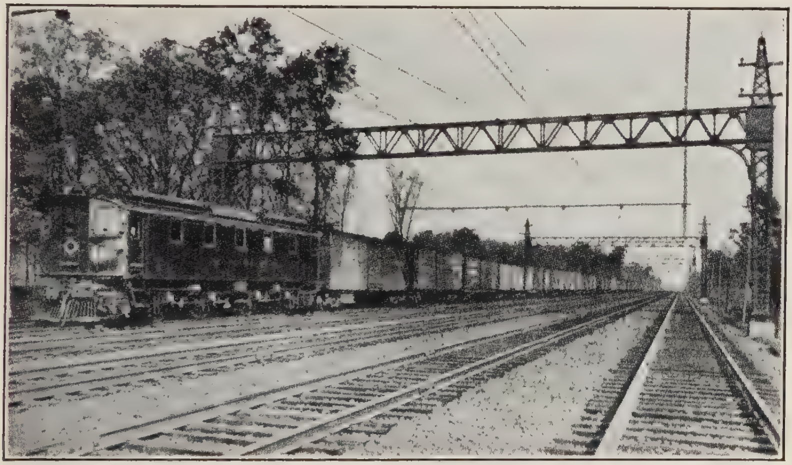

Fig. 193.—Freight train on New Haven's six-track Harlem River Branch.

The elimination of smoke is also a factor in raising the value of land along the right of way. No further proof of the fact is needed than to point out that among the strongest supporters of electrification about any city are those owning property near the right of way. But outside of this fact it is not difficult to see that a site is much more desirable if it is not subjected to a constant shower of cinders and is frequently overcast by dark clouds of smoke.

It will be seen, therefore, that by the elimination of smoke the public travels with much more comfort than under steam operation, that the property along the railroad right of way is much benefited, that operation through tunnels is made more safe, and that the land capacity of the terminal is more fully utilized.

It is the contention of the exponents of electric operation that the electric locomotive is in numerous respects more efficient than the steam locomotive. In the first place it is pointed out that the entire weight of the electric locomotive can be and frequently is on the drivers, while but 65 per cent. to 75 per cent. of the steam locomotive (except the switching type) is thus utilized. It is also shown that a steam engine must haul its own fuel and water and that this additional weight cannot be utilized to increase the adhesion by being carried on the driving wheels.[1] An electric locomotive has no burden of this kind.

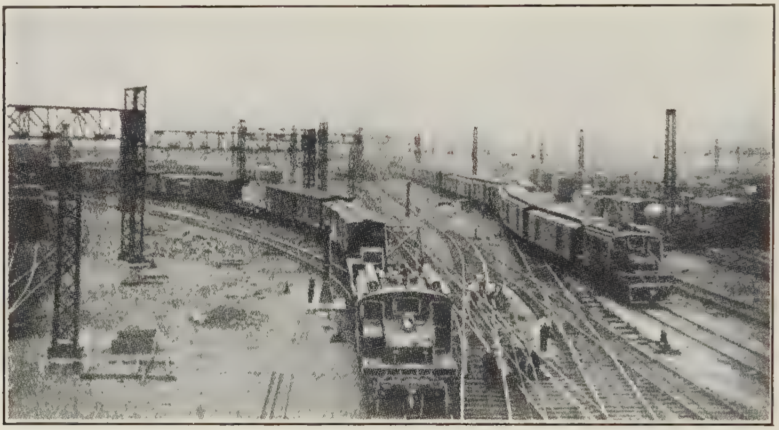

Fig. 194.—New Haven locomotive in switching service.

The second argument brought forward is that an electric locomotive allows an increase in tractive effort without a decrease in speed. A limiting factor of the horsepower output of a steam locomotive is the amount of coal per hour which the fireman can throw onto the grate continuously throughout his shift.[2] Horsepower is equal to the tractive effort in pounds times the speed in miles per hour divided by 375. If the horsepower is limited by the strength of the fireman an increase in tonnage can be secured only by a decrease in speed and an increase in speed can be obtained only by lowering the tonnage hauled. In the case of an electric locomotive there is constantly available all of the power which the locomotive requires. Its horsepower capacity can be used continuously and is not limited by outside factors. It is possible, therefore, to haul full tonnage without a decrease in speed.

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[1] There are a few engines which have a second (as in the case of certain locomotives on the Southern Railway), or third (the Erie Triplex) engine with a complete and separate set of driving wheels under the tender, but the number of such locomotives is very small. Among roads using electric road engines with all the weight on the driving wheels are the New York Central (Fig. 190), and the Butte, Anaconda & Pacific (Fig. 191).

[2] This argument, of course, does not apply in the case of automatic stoker-fired engines of which there are over 1500 in service.

There are qualifications to this argument, however, which should be made. In the first place the electric locomotive has a limiting factor which cannot be disregarded, the amount of current which the locomotive can take from the line before heating of the leads and armatures begins. The question of the overheating of motors is serious, and one which does not enter into steam operation. If a steam engine is overloaded it stalls and blocks the main line. It may cause delays, but nothing more serious results. The overheating of an electric locomotive, on the other hand, causes damage to the apparatus, which is most expensive to repair. In this the cost of operation of electric power may be abnormally increased, as compared with steam, by reason of its susceptibility to serious damage following slight negligence in operation.

In the second place the electric locomotive has a horsepower limit. Maximum tonnage cannot be hauled at maximum speed. The rating of the locomotives in fast freight service is uniformly lower than in slow freight service. It may be true that the horsepower capacity of an electric locomotive is greater than a steam locomotive of the same size and weight and in this sense the electric engine is more efficient. Each, however, has its limiting factor. The electric engine simply has the advantage of not being limited by outside factors.

The third argument as to the higher efficiency of the electric engine is that it can exert twice its normal tractive power for short periods. As pointed out above, overheating will be brought about if an excessive amount of current is taken from the line for any length of time. For short periods, however, much more than the normal amount can be taken without danger of overheating. The marginal lines, in such cases, between overheating and normal heating are not far apart. It is obvious that this is a considerable advantage when for a short time the locomotive is called upon to do more than its normal work. While a steam engine might become stalled and an engine failure result, the electric engine experiences no trouble.

Lastly, the electric locomotive can be used to its rated capacity for the entire year, while the rating of a steam locomotive must be reduced during the winter months. In the winter both types of locomotives must perform a greater amount of work in hauling the same tonnage, because of increased journal resistance during cold weather. The steam locomotive is further handicapped by radiation losses, greater cylinder condensation, etc. The usual policy is to reduce the rating of steam locomotives, in proportion to the drop in temperature, from 5 to 25 per cent. Under electric operation, however, there is no handicap to the locomotive itself, because of the cold weather. It is, on the contrary, aided by cold atmosphere which reduces the heat in the motors and causes increased capacity, enabling heavy effort for longer continued periods than during summer. The actual tractive power of the electric locomotive is, therefore, greater in winter than in summer, but because of the greater resistance to be overcome per unit of weight, the rating is usually the same as in the summer months.

The third general advantage which is ascribed to electric operation is the benefits derived from the elimination of the work of terminals necessary when steam locomotives are used.[1] A steam engine must take on coal and water, its fires must be cleaned, at the beginning of the day its fire must be started or raked forward, at the end of the day the fires must be drawn or banked. This not only causes additional expense but requires that the locomotive be out of service for considerable periods. If the engine is used in long runs some of this work must be performed between trips. The electric locomotive requires no work of this character. It must be frequently inspected, but the same is necessary for steam locomotives. Outside of this the electric locomotive need not be taken from service at all. It may be used constantly for 24 hours a day, if there is work for it. With the same service to be handled there should be less electric locomotives necessary than steam locomotives, unless there are peculiarities in the service itself.

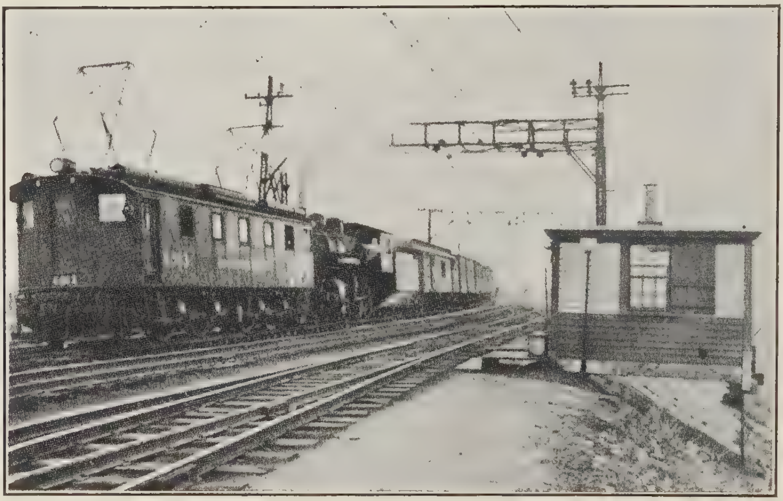

FIG. 195.—Hoosac tunnel electrification, Boston & Maine.

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[1] The electrification of the Pennsylvania out of its Philadelphia Broad Street station was primarily undertaken to increase the terminal capacity.

There are conditions, however, when this advantage is to some extent nullified. If the traffic of the railroad is very heavy during a few hours of the day and much lighter during the remaining period—a very usual condition in everyday practice—a number of locomotives will be required during these hours which are not used during the period of light traffic. This is most strikingly shown under the conditions of commuter service. As many electric locomotives as steam are necessary for a short time, but some of these will have little to do for the balance of the day, though they are capable of making double the mileage. In the same manner, if the freight service is particularly heavy during certain periods the freight locomotives cannot be used to capacity. This point is made in order to show that under peculiar conditions of traffic this advantage of the electric locomotive cannot be utilized.

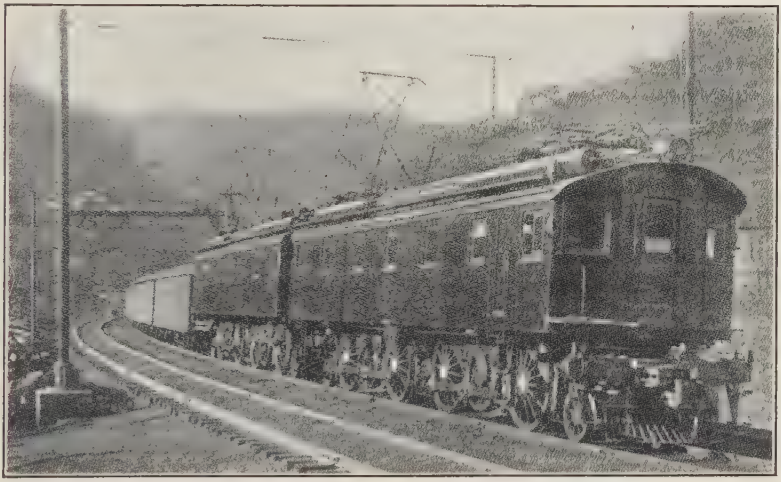

Fig. 196.—Heavy freight train on Norfolk & Western.

Turning to the disadvantages of electric operation and to arguments of its opponents we find that the most important objection is the enormous first cost and the heavy fixed charges which that involves. It is pointed out that very heavy capital expenditures must be made for both line and equipment and it is argued that the interest on this investment is more than enough to offset whatever economies are made in operating expenses. That the cost of electrification is very heavy cannot be denied. There is in the first place the power house which furnishes the power to the trains. If the electric zone extends a great distance, more than one power house is necessary, since there are heavy losses when the current is transmitted over long distances. The New Haven with 82 miles of road electrified has but one power house, but it is now aided by the arrangement with the New York Edison Company. The cost of a power house of capacity sufficient to operate heavy train service is high. The current having been generated must be transmitted to trains. If the direct current is used substations are necessary. If the voltage is low the third rail is required. When the overhead transmission system is used, a heavy expenditure is required for the catenary bridges, and the messenger, feed, control, and trolley wires. Where the line is sectionalized anchor bridges must be installed. Whether the system is alternating or direct current, therefore, this large capital outlay must first be made. Not only are the additional changes necessary for the transmission lines, but the equipment is much more costly. At the present time electric locomotives cost from 50 per cent. to 100 per cent. more than steam locomotives of the same capacity and power. It is probable that this difference will be less when the manufacture of electric locomotives is standardized and the number of locomotives being built is greater. At present, however, the original cost of the equipment is much higher than for steam locomotives of equal tractive power.[1]

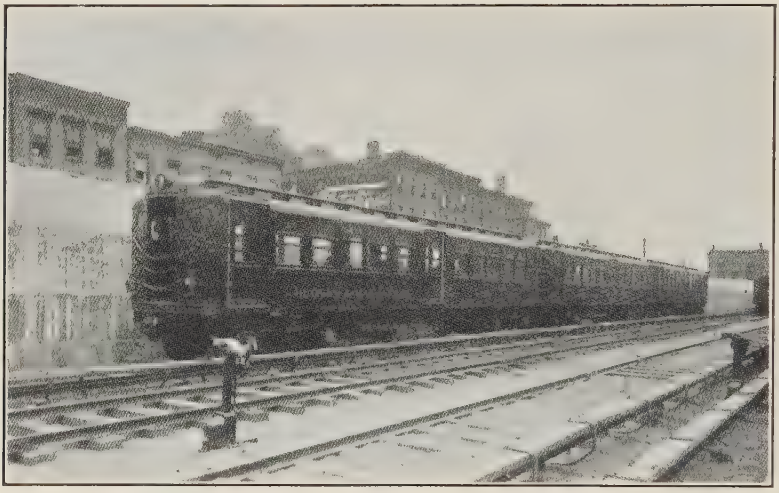

FIG. 197.—Hudson & Manhattan multiple-unit train.

On the other hand it is pointed out that certain facilities required under steam operation may be eliminated when electification is complete. The most important are the engine house facilities. Coaling pockets and ash-pit facilities will no longer be necessary, while the engine house can be of much simpler design. Engine houses will be needed for minor repair work and for inspection, but the cost should be considerably less. In spite of these factors, however, the railroad is confronted with the necessity of heavy initial expenditures and fixed charges which are not incurred under steam operation. Electrification, therefore, must not only bring about economies, but very large reductions in operating cost in order to prove itself economical.

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[1] A month's operation on the New Haven as shown in operation statistics will be found on pages 384 to 388.

The second objection which is raised in opposition to the electric operation is the additional danger to the lives of the employees and others. This is, of course, much more serious when the voltage transmitted is high, and where freight and switching service as well as passenger is operated by electric power. Elaborate precautions have been taken by all roads using electric power to guard the lives of employees and others who might come into contact with wires or other apparatus charged with electricity. Where the third-rail is used it is guarded by a wooden shield on the top and one side. On the New Haven where the high voltage transmission is used, the trainmen are forbidden to go on the top of cars except at specified points. The entire line has been measured to determine the distance between the rail and the trolley wire. Illuminated signs have been placed at frequent intervals, showing whether at those points the line is lower or higher than the safe limit. By bulletins and instructions the men are informed as to the low and high points in the line. The same method has been used in the yard where brakemen are likely to ride on cars while switching. They are forbidden to ride on the tops of cars and are thoroughly informed as to the dangerous points. By this thorough campaign injuries and deaths due to contact with live wires have been few. When there has been an injury it has been due to carelessness and disobedience of instructions. Nevertheless it must be admitted that there is a source of danger, and that only by strict discipline on the part of the management and

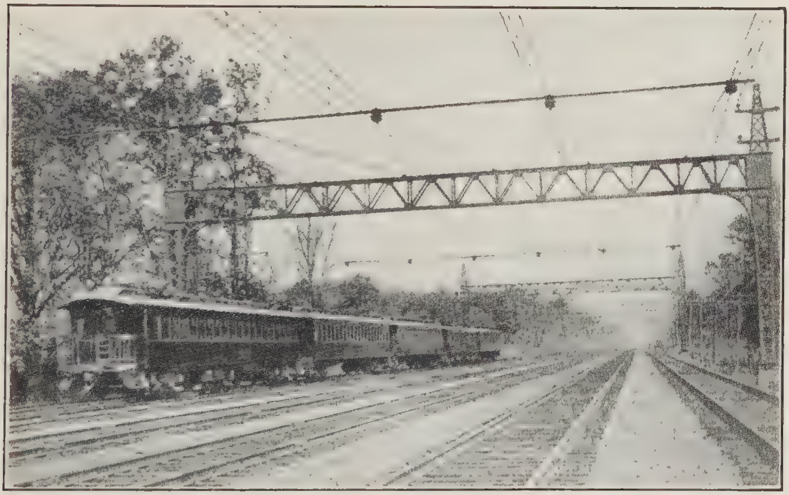


Fig. 198.—New Haven multiple-unit train on six-track Harlem River Branch.

observance of rules on the part of the employees can this danger be eliminated.

There are, however, many kinds of accidents characteristic of steam operation which are eliminated. Chief among these are those due to scalding steam. The opponents of electric operation sometimes remember only the new source of accidents and fail to recollect that an old source has been eliminated. If, therefore, the sum total of accidents under the two systems is considered, it is quite probable that the showing under electric operation is as good as that under steam.

The third argument against electric operation is that which deals with the additional liability of train delays. In addition to equipment failures which occur in both steam and electric service, there are failures of the transmission lines. The breaking of an insulator will ground an entire section and delay every train in that section until the insulator is replaced If the road has four tracks other trains may be sent around the dead section, but this involves a certain amount of delay. It has been noted that extreme conditions of heat and cold will sometimes cause a large number of failures on the line. There is in addition to the line failure the possibility of the power house being out of commission, in which case the entire electrified section is tied up. It should be said, however, that these delays are rare.

As to the comparative efficiency of the two types of locomotives in the matter of failures, the electric locomotive seems to hold its own. This is surprising in view of the comparative state of the science in the construction of the two types. The favorable showing of the electric locomotive is probably due in a considerable degree to the internal simplicity of the apparatus and to the fact that the moving masses are rotating rather than reciprocating. There are certain factors, however, which within the last four or five years have made the steam locomotive a more formidable competitor of electrification. These are, particularly, the various outside valve gears, the superheater, the brick arch and the automatic stoker which have increased the tractive power and sustained hauling power of an engine as well as resulting in greater economy of fuel and water. Greater attention is now being paid to the general design and adaptability of the steam locomotive, and improvements are now under way which should result in still further increased efficiency. The development of the use of pulverized fuel in locomotives is of outstanding importance from the standpoint of both hauling capacity and fuel economy and much is perhaps to be expected from the possible development of the feed water heater and other such devices. Taking operation as a whole, the fact remains further that there are additional causes of delay in electric operation, factors of considerable importance at times. With increased experience these factors should be made of much less importance.

The exponents of electrical operation claim a large saving in operating expenses to offset the heavy fixed charges; the opponents argue that whatever saving is made by electrification is not enough to offset the additional fixed expense and, further, that though there may be a saving in some items of expense there is heavier cost in others. It is on this point that the opposing sides are most at odds and it is this question which is at present the hardest to answer. Figures of all kinds are available to prove both sides of the question, but there are so many factors entering into them that it is exceedingly difficult to answer the problem definitely at the present time.

The electrical engineer maintains that under electric operation there is a saving in fuel of 50 per cent. Since fuel is the largest single item in operating expenses a saving as large as this would surely go far to offset the fixed charges. It is pointed out that the central plant which furnishes the power to electric trains is much more efficient than the steam locomotive, that in the use of coal it consumes but one-half the amount required by a steam locomotive to haul the same tonnage. Furthermore attention is called to the fact that while a steam engine is standing on a siding it is consuming coal, when it is coasting it is also using fuel. An electric locomotive, on the other hand, uses no power except when it is exerting tractive effort. When it is standing or when it is coasting the power is shut off. It creates a demand on the power house, therefore, only when actually working. This results in still greater economy in the use of fuel.

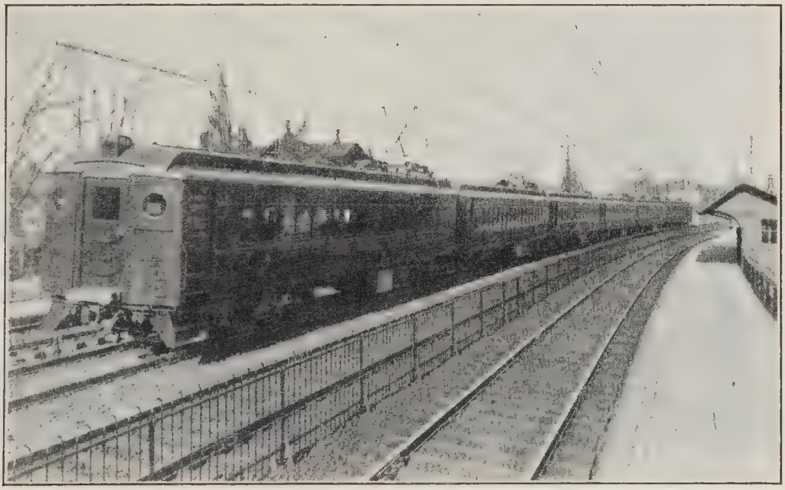


FIG. 199.—Pennsylvania multiple-unit train, Philadelphia-Paoli service.

There is little doubt that there is a saving in the cost of fuel when electric power is used. Whether the saving amounts to one-half the total coal consumed is more doubtful. There are other considerations entering into the problem which the supporters of electrification have not brought out. Assuming that they are correct in stating that the power houses consume but one-half as much coal for the same number of ton miles, the cost of power would be more than one-half of the cost of coal. For there are other factors entering power-house costs which do not appear in the cost of coal. The cost of other supplies than coal, the cost of power-house labor, and the expense of maintaining the power house and its equipment are items of no mean importance. This fact should be constantly borne in mind when discussing the relative costs of power and fuel.

There is another factor entering the cost of power which does not affect the cost of fuel. There is a transmission loss between the power house and the locomotive. These losses increase with the distance between the power house and the trains. On the New Haven, when the entire 82 miles of line were supplied by one power house, the line losses were between 6 and 7 per cent. Under the direct-current system the losses of this character are considerably greater, since the power passes through a substation in addition to the transmission lines. The cost of the loss in current must be borne by the other classes of service which means an increase approximately equal to the percentage of line loss. From this it will be seen that wherever there is undoubtedly a saving in the cost of power, that saving is not 50 per cent., even though the power house is twice as efficient in the consumption of coal as the steam locomotive. Other factors enter into the calculation which in fairness must be charged against the cost of electric power.

Fig. 200.—Long Island suburban train, New York.

A fair comparison of the cost of repairs to steam and electric locomotives is particularly difficult, since the latter are yet in the experimental stage. The advocates of electric operation claim that because of the simplicity of the electric apparatus the cost of repairs is much less than for the more complicated steam engine. Experience, however, has not always proved this correct. The repair costs in some instances have been as high or higher than those of steam locomotives. This, however, should not be taken as the permanent result. Neither the mechanical nor the operating men have had the experience with the electric locomotive, and the locomotive itself should be much improved during the next few years as a result of their experience. It is probable that the repair costs will be materially reduced. At the present time it is impossible to say whether the saving claimed will be affected.

The cost of locomotive supplies does not materially differ between the two types of locomotives except in the winter months. At that time the cost under electric operation will be higher except when motor cars are used. The steam for heating a train hauled by a steam locomotive is at hand and its cost is not a factor of very great importance. Under electric operation, however, the steam must be generated in flash boilers, using oil for heating. The cost of this oil is an appreciable item and raises the cost of locomotive supplies above that of steam locomotives.

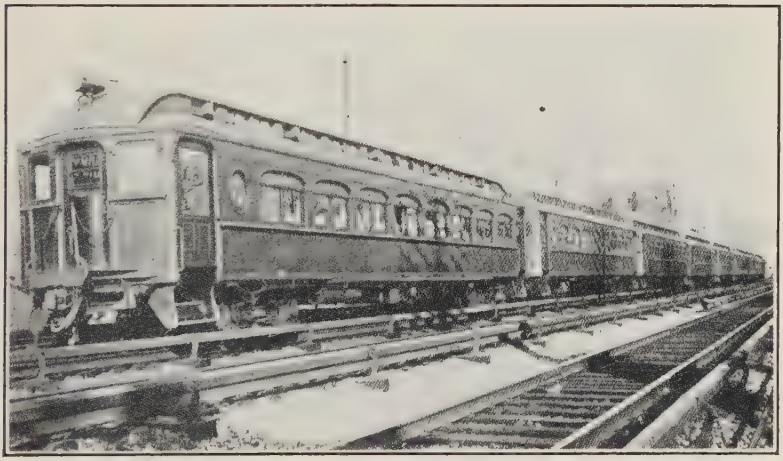


FIG. 201.—New York Central multiple-unit train, New York.

On turning to engine house expenses we find that the opposite is true. With no fires to clean or ashes to handle, no turning of engines, no firing of locomotives in preparation for the day's work, the chief items of engine house expenses are eliminated. While the engine house expenses of steam locomotives are important factors they are insignificant in electric operation. It is here that it effects one of its most marked economies.

The average rate of enginemen is slightly lower in electric service than in steam In the latter the rates vary in accordance with the size of the locomotive, in electric operation there is a flat rate for each class of service. This would tend to make the costs in electric service slightly lower. In freight service there is another factor tending to reduce further the cost under electric operation. It was pointed out in the first section of this chapter that two or more electric engines coupled together may be operated by a single engine crew. This possibility of doubleheading without additional engine crews results in a considerable saving. This argument, of course, assumes that electric engines have as great a tractive power as the steam locomotive. With conditions the same, the cost of this item should be less in electric service.

There is no difference in the rate of wages for trainmen whether the service is operated by steam or electric power. The cost per train or per car mile will be the same when the conditions of service are the same. In freight service the saving will be made where there is the opportunity to operate heavy trains. Twice the number of men are not required when the train is a doubleheader. This applies whether the power used is electric or steam. It is evident, therefore, that the cost will not vary with the type of operation, but with the conditions of the service.

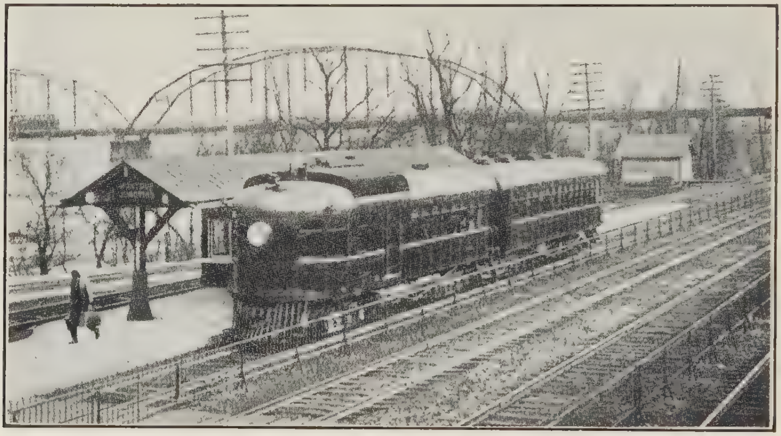


Fig. 202.—Gas-electric motor car, Pittsburgh & Lake Erie.

There is an indirect saving which is made under electric operation which deserves mention, a saving applying to freight and switching service. That saving is in drawbars on freight cars. One who has seen a long freight train started by an electric engine understands how easily the slack is taken up, even while the train gains speed faster than if a steam engine were hauling it. This economy in drawbars cannot be easily determined, but it is indisputable that a considerable saving is made.

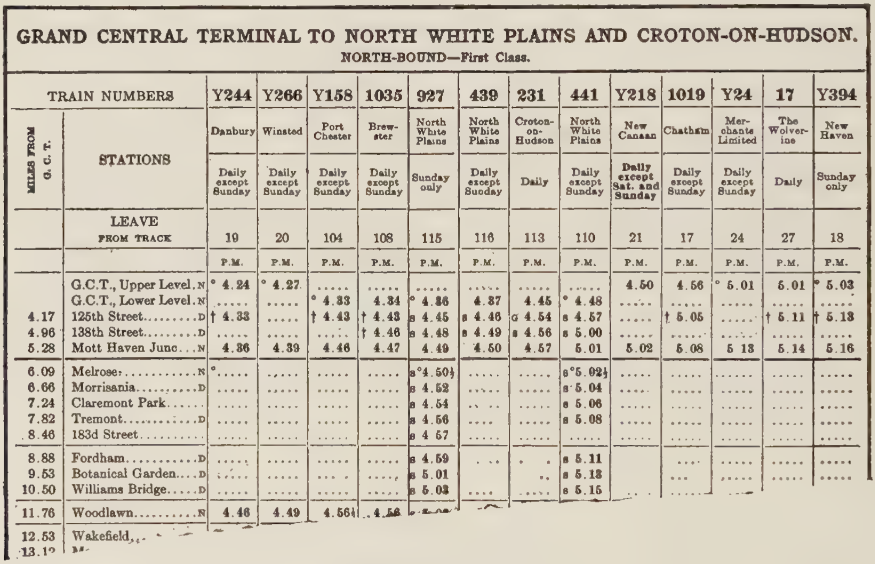
In this discussion of operating costs and indeed throughout the chapter, the writer has avoided the use of specific figures. As stated before, electric operation has by no means reached its normal stage. The figures and facts of today will be far from the truth in a few years when the benefits of present experience begin to be realized. This is particularly true of railroads like the New Haven which are just beginning to use electric power on entire divisions for all classes of service, rather than for suburban passenger service only. At the present time the saving in operating costs do not appear to approach the very heavy addition in fixed charges, but this is true only for the present. One would be presumptuous to prophesy what the future will bring forth. Great improvement, however, should be shown during the next few years and it will be wiser and safer at that time to discuss the permanent results of electrification rather than now when we are yet in the early stages.

CHAPTER XVIII

TIME-TABLES AND TRAIN SCHEDULES

The first, if not the most important feature that must be considered in connection with passenger train operation is the working out of a time-table.

In the Standard Book of Rules, the time-table is defined as: "The authority for the movement of regular trains subject to the rules. It contains the classified schedules of trains with special instructions relating thereto."



GRAND CENTRAL TERMINAL TO NORTH WHITE PLAINS AND CROTON-ON-HUDSON.
NORTH-BOUND—First Class.

MILES FROM G. C. T.	TRAIN NUMBERS	Y244	Y266	Y158	1035	927	439	231	441	Y218	1019	Y24	17	Y394
	STATIONS	Danbury	Winsted	Port Chester	Brewster	North White Plains	North White Plains	Croton-on-Hudson	North White Plains	New Canaan	Chatham	Merchants Limited	The Wolverine	New Haven
		Daily except Sunday	Daily except Sunday	Daily except Sunday	Daily except Sunday	Sunday only	Daily except Sunday	Daily	Daily except Sunday	Daily except Sat. and Sunday	Daily except Sunday	Daily except Sunday	Daily	Sunday only
	LEAVE FROM TRACK	19	20	104	108	115	116	113	110	21	17	24	27	18
		P.M.	P.M.	P.M.	P.M.	P.M.	P.M.	P.M.	P.M.	P.M.	P.M.	P.M.	P.M.	P.M.
	G.C.T., Upper Level. N	° 4.24	° 4.27	.....	.....	.....	.....	.....	.....	4.50	4.56	° 5.01	5.01	° 5.03
	G.C.T., Lower Level. N	.....	.....	° 4.33	4.34	° 4.36	4.37	4.45	° 4.48	.....	.....	.....	.....	.....
4.17	125th Street.........D	† 4.33	.....	† 4.43	† 4.43	s 4.45	s 4.46	G 4.54	s 4.57	.....	† 5.05	.....	† 5.11	† 5.13
4.96	138th Street.........D	.....	.....	.....	† 4.46	s 4.48	s 4.49	s 4.56	s 5.00	.....	.....	.....	.....	.....
5.28	Mott Haven Junc...N	4.36	4.39	4.46	4.47	4.49	4.50	4.57	5.01	5.02	5.08	5.13	5.14	5.16
6.09	Melrose............N	°	.....	.....	.....	s ° 4.50½	.....	.....	s ° 5.02½	.....	.....	.....	.....	.....
6.66	Morrisania..........D	.....	.....	.....	.....	s 4.52	.....	.....	s 5.04	.....	.....	.....	.....	.....
7.24	Claremont Park......	.....	.....	.....	.....	s 4.54	.....	.....	s 5.06	.....	.....	.....	.....	.....
7.82	Tremont.............D	.....	.....	.....	.....	s 4.56	.....	.....	s 5.08	.....	.....	.....	.....	.....
8.46	183d Street..........	.....	.....	.....	.....	s 4 57	.....	.....	.....	.....	.....	.....	.....	.....
8.88	Fordham...........D	.....	.....	.....	.....	s 4.59	.....	.....	s 5.11		.....	.....	.....	.....
9.53	Botanical Garden....D	.....	.....	.....	.....	s 5.01		.....	s 5.13		.....	.....	.....	.....
10.50	Williams Bridge.....D	.....	.....	.....	.....	s 5.03	.....	.....	s 5.15	.....	.....			
11.76	Woodlawn..........N	4.46	4.49	4.56½	4.58	[illegible]								
12.53	Wakefield													
13.1	M													

FIG. 203.—Typical time-table for four-track road.[1]

The schedule is defined as: "That part of a time-table which prescribes the class, direction, number and movement of a regular train."

Pages from typical time-tables are reproduced in Figs. 203 and 204. From these one may obtain an idea of the schedules. It will be seen that there are specified: the direction, the class of trains involved, the number of each of these trains, the name of each train, the days for which it is scheduled and the time at various points in the run, those points at which stops are made being designated by the letter "s." The time-table from which one page shown is taken applies on a four-track line. The other time-table containing schedules for a single-track line also indicates in which direction trains are superior;[1] that is, whether north or east bound trains are superior to south or west bound trains or *vice versa.* Meeting and passing points are indicated by figures in black-face type.

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[1] Sunday trains on this time table are shown in red.

The time-table, in addition to containing the schedules also contains pages of special instructions which for one reason or another may not be contained in the rule book. Included are special rules applying only on the division concerned, and other important information relating to the operation of trains, such as the location of standard clocks, bulletin boards and water stations; the location and capacity of sidings, and the locations of signals, grade crossings and drawbridges. Rules are also included governing the maximum weights of equipment which may be used over various parts of the line. In nearly every time-table various speed restrictions are given, not only over the road as a whole but for sharp curves, interlocking, crossovers, drawbridges, threatened weakness in subgrade and similar reasons. Many time-tables contain so-called speed schedules by means of which an engineman may easily ascertain the speed of his train by the minutes and seconds elapsing in covering the distance between any two stations.

Present-day time-tables are necessarily an evolution from early times and in most cases, they have grown up gradually with the railroads they govern. Although it is only seldom at present that entirely new time-tables are constructed, it would, nevertheless, be illustrative of other present-day problems to sketch some of the influences met in the construction of train schedules. The ideal result in any case would be a time-table which would at the same time provide the service demanded by the public and permit of economical operation. That this result is never realized goes without saying, for no time-table will satisfy all the patrons, and economy of operation will too often be sacrificed for public convenience.[2] The problem is one that needs the best talent of both the operating and traffic departments and the hearty coöperation of all concerned. The traffic department, on the one hand, figuratively speaking, has its finger on the pulse of public wishes. It is best acquainted with the traffic needs at each point, the connections which must be made with foreign lines and the service of competing lines. The operating de-

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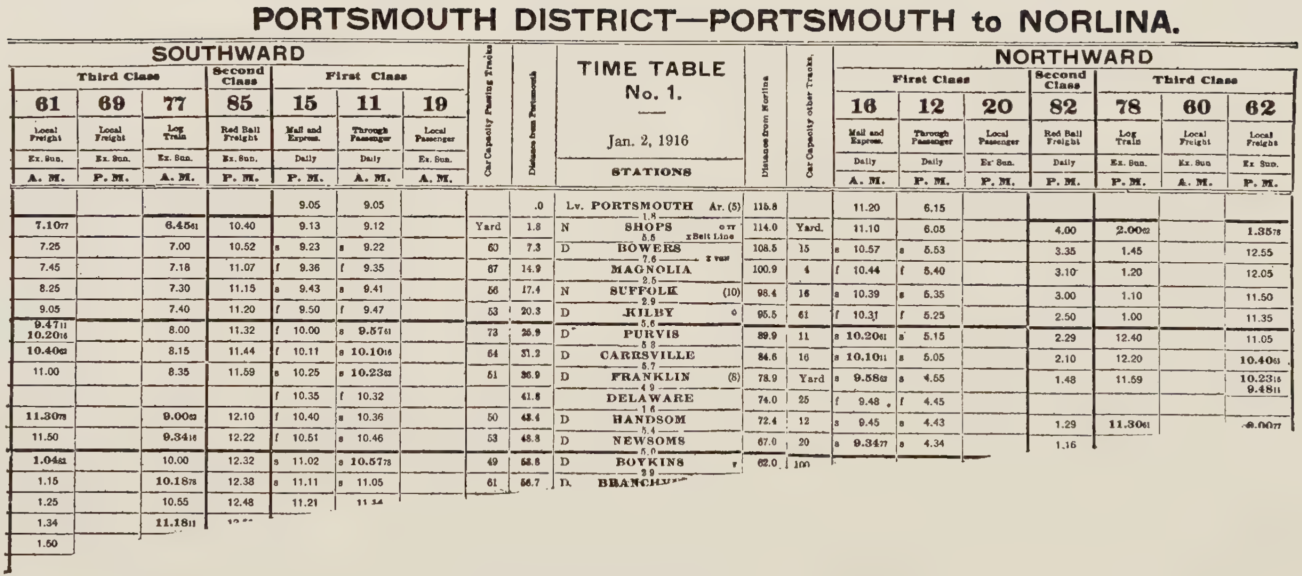
[1] Unless the so-called "positive meet" rule of the New Haven and certain other busy roads is used in lieu of the "right by direction." This is rule 83 in the New Haven operating book and reads as follows: "On single track, trains must wait indefinitely at meeting points for opposing trains of the same class unless otherwise directed by train order, except as otherwise provided in this rule."

[2] Erroneous and midleading conclusions are frequently reached by balancing an operating saving of a dollar against a dollar's worth of traffic revenue (gross) instead of considering the dollars saved (net) as the equivalent of the gross amount of receipts necessary to produce a dollar in profit; perhaps 10 or 15 times as much.



PORTSMOUTH DISTRICT—PORTSMOUTH to NORLINA.

SOUTHWARD									TIME TABLE No. 1. Jan. 2, 1916				NORTHWARD						
Third Class			Second Class	First Class			Car Capacity Passing Tracks	Distance from Portsmouth			Distance from Norlina	Car Capacity other Tracks	First Class			Second Class	Third Class		
61	69	77	85	15	11	19							16	12	20	82	78	60	62
Local Freight	Local Freight	Log Train	Red Ball Freight	Mail and Express	Through Passenger	Local Passenger							Mail and Express	Through Passenger	Local Passenger	Red Ball Freight	Log Train	Local Freight	Local Freight
Ex. Sun.	Ex. Sun.	Ex. Sun.	Ex. Sun.	Daily	Daily	Ex. Sun.				STATIONS			Daily	Daily	Ex Sun.	Daily	Ex. Sun.	Ex. Sun	Ex Sun.
A. M.	P. M.	A. M.	P. M.	P. M.	A. M.	A. M.							A. M.	P. M.	P. M.	P. M.	P. M.	A. M.	P. M.
				9.05	9.05			.0	Lv.	PORTSMOUTH Ar. (5) 1.8	115.8		11.20	6.15					
7.10_{77}		6.45_{61}	10.40	9.13	9.12		Yard	1.8	N	SHOPS o T T 5.5 x Belt Line	114.0	Yard.	11.10	6.05		4.00	2.00_{62}		1.35_{78}
7.25		7.00	10.52	s 9.23	s 9.22		60	7.3	D	BOWERS 7.6 x [illegible]	108.5	15	s 10.57	s 5.53		3.35	1.45		12.55
7.45		7.18	11.07	f 9.36	f 9.35		67	14.9		MAGNOLIA 2.5	100.9	4	f 10.44	f 5.40		3.10	1.20		12.05
8.25		7.30	11.15	s 9.43	s 9.41		56	17.4	N	SUFFOLK (10) 2.9	98.4	16	s 10.39	s 5.35		3.00	1.10		11.50
9.05		7.40	11.20	f 9.50	f 9.47		53	20.3	D	KILBY o 5.6	95.5	61	f 10.31	f 5.25		2.50	1.00		11.35
9.47_{11} 10.20_{16}		8.00	11.32	f 10.00	s 9.57_{61}		73	25.9	D	PURVIS 5.8	89.9	11	s 10.20_{61}	s 5.15		2.29	12.40		11.05
10.40_{62}		8.15	11.44	f 10.11	s 10.10_{16}		64	31.2	D	CARRSVILLE 5.7	84.6	16	s 10.10_{11}	s 5.05		2.10	12.20		10.40_{61}
11.00		8.35	11.59	s 10.25	s 10.23_{62}		51	36.9	D	FRANKLIN (8) 4.9	78.9	Yard	s 9.58_{62}	s 4.55		1.48	11.59		10.23_{16} 9.48_{11}
				f 10.35	f 10.32			41.8		DELAWARE 1.6	74.0	25	f 9.48	f 4.45					
11.30_{78}		9.00_{62}	12.10	f 10.40	s 10.36		50	43.4	D	HANDSOM 5.4	72.4	12	s 9.45	s 4.43		1.29	11.30_{61}		9.00_{77}
11.50		9.34_{16}	12.22	f 10.51	s 10.46		53	48.8	D	NEWSOMS 5.0	67.0	20	s 9.34_{77}	s 4.34		1.16			
1.04_{82}		10.00	12.32	s 11.02	s 10.57_{78}		49	53.8	D	BOYKINS 3.9	62.0	100							
1.15		10.18_{78}	12.38	s 11.11	s 11.05		61	56.7	D.	BRANCH									
1.25		10.55	12.48	11.21	[illegible]														
1.34		11.18_{11}	[illegible]																
1.50																			

FIG. 204.—Section of time-table for single-track line.

partment, on the other hand, knows the physical limitations of the road and the other practical factors affecting the operation of trains. On the operating department rests the responsibility for economical operation, and it is that department that must attempt to eliminate, in so far as possible, all wasteful and uneconomical conditions.

The factors which enter into consideration may be divided into two general classes: (1) those in which the public is primarily interested, the problems of adequate service; (2) those in which the railroads as business enterprises are interested, the problems of revenues and expenses. While it is true that the public and the railroads are very much dependent, the one upon the other, this distinction may be made to show the division of interests and the necessity for compromise.

The first and most fundamental rule governing the construction of the time-table is that it should contain no elements endangering the lives of employees or passengers. No such combination of trains should be run as will increase the hazard of collisions. Trains should not be run so near together or meets, on a single-track line, made so close as to introduce an element of danger. The chance of such trouble under present-day operation is, of course, very slight, not only because of the introduction of automatic signaling devices, but because operating men have become sufficiently experienced to surmount these difficulties.

Excessive speed, either for a whole or a part of a train's run is decidedly a hazard. Competition in fares is now largely a thing of the past, and has long since been succeeded by a competition in service. Such presumes the operation of de luxe trains at high speeds. It is true that in very recent years there has been a strong tendency away from the so-called "high-speed craze." A long line, endeavoring to compete with a shorter one, frequently finds it necessary, however, to maintain an excessively fast schedule for some of its trains On any road, certain trains not running on fast through schedules may have to maintain a high rate of speed over parts of the run. For the safe operation of high-speed trains, there must be the best possible roadway and track. The equipment must be constantly maintained at the highest possible standard; the road must be adequately signaled, and the engines operated by men of long experience. Even these safeguards will not entirely eliminate the dangers arising from excessive speed. For that reason no schedule demanding excessive speed at any point in the run can be free from criticism. The attainment of a proper result demands a thorough knowledge of the line over which the train runs and of the time which the train should require over each stretch of track.

The second requisite of every passenger time-table is that it supply the transportation needs of the public. For a railroad to suit all the public is, of course, beyond the realms of possibility. Not only each station on the line, but each passenger, wishes trains at certain periods of the day. Each town in a suburban zone wishes express as well as local service to the city and frequent service, in particular, in the morning and afternoon. It is in suiting the conflicting wishes of the many patrons that the traffic man can be of greatest assistance. He should be able to tell the operating man the amount of traffic from each of these cities and towns, whether that traffic is continuous or spasmodic, and whether it is largely local or an appreciable number of through passengers board or leave a train at that point. On the basis of this information, those who are making up the time-table can decide at what points express trains should be stopped, and how many trains should be stopped at each point during the day. They can determine how many commuter trains should run express to and from the terminal. This information will enable them to decide the necessities of morning and afternoon suburban passengers. The problems, in short, are so many that solutions cannot be reached that will be satisfactory for all the patrons. The old principle of the "greatest good to the greatest number" must be the ruling factor.

Satisfactory service to the patron depends largely on the speed of the train. The average traveler wishes to spend as little time as possible in the cars. The faster the train and the fewer the stops, the better he will be satisfied, provided there is no danger of accident and provided the schedule is regularly maintained.[1] Due consideration should also be given in this matter to connections with branch-line trains and trains of other roads.

Safety, frequent service, both express and local, and fast schedules regularly mantained are the principal factors the public demands. It is not difficult to see that some of these are contradictory and that compromises must be made to permit a schedule both satisfactory to the public and practicable of operation. The needs of the carriers themselves must also receive consideration. Passenger traffic should, in the first place, pay the direct expense of operating it, and in addition a fair proportion of the fixed and overhead charges. Furthermore, under ordinary circumstances, each train should at least earn enough to pay the direct expenses incurred in its operation. All railroad men are aware, however, that many trains are run which do not earn their out-of-pocket costs. In certain cases this is impossible to avoid. For example, on many branch lines, where travel is light and but one or two passenger trains are run each day, it would be impossible in most cases to reduce the service no matter how low the earnings. A certain amount of passenger train service may be necessary to stimulate freight traffic by rendering a section of country more attractive for the location of industries and enabling salesmen and others to get about. On main lines, however, where traffic is heavier, the operation of many trains which do not pay expenses is economically unjustified. It is all the worse, in that the public itself suffers in the long run. From the viewpoint of the railroad, and from that of the public, too, the time-table should contain the fewest possible trains that do not earn their share of operating expenses.

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[1] The various State Public Service Commissions now quite generally take the advanced stand that more fault will be found if a schedule is imperfectly maintained than if train speeds are moderate.

The steam railway train consisting of a locomotive and two or three passenger cars is not an economical unit for average branch line-service. This is clearly shown by the ease with which the interurban trolley lines or even jitneys compete with steam service under such conditions. Presumably the steam railway is chiefly handicapped in a competition of this kind by its higher fares and lack of frequent service. The out-of-pocket costs for operating a small passenger train average between 50 and 60 cents per train mile. When it is considered that a railway is fortunate if it can secure greater operating revenues per train mile in branch-line service than 50 cents, it is easily explained why the fares are not reduced or more trains run. Nor is it strange under such conditions that the branch-line trains are usually made up of antiquated and shabby equipment, that their schedules are subordinated to more important paying freight trains or that the questions of branch-line service are among the most irritating problems before the public service commissions at the present time. The difficulty of operating non-paying local service on main lines is even more troublesome for there it is further complicated by the greater density of traffic and the ever present temptation to stop heavy through trains to handle purely local business.

Some remedies have been suggested to enable steam railways to meet this problem of supplying successfully an adequate and profitable branch-line or local service. One is electrification, the success of which for this purpose is clearly shown by the rapid extension of electric interurban lines and the results of operation on such lines as the New York, Westchester & Boston; the Spokane & Inland Empire; the Piedmont & Northern and many others. The high cost of the investment for electrification, however, has hindered many roads from resorting to it. Some have tried to find a solution of the problem, instead, in the self-propelled gasolene car. There are two important classes of this type of car, one being the direct-driven car in which power is transmitted directly from a powerful gasolene engine to the axle by a silent chain or similar means, and the other, the so-called gas-electric car in which a gasolene engine operates a generator supplying electricity to the electric motor which drives the car. The best makes of these cars are of standard all-steel construction. They sometimes have a baggage compartment and usually can seat from 60 to 80 persons. Their engines are powerful enough so that they can also haul a trailer. They are capable of a speed of over 45 miles an hour and can therefore operate on the same rails with fast high-grade through trains. The makers of the gas-electric cars (see Fig. 202) assert that their cars can operate at an out-of-pocket cost of from 16 to 29 cents a mile, the company having secured figures showing a mileage of 752,965 made by 43 of its cars at an average cost of 18.69 cents a mile, divided as follows:

	Per train mile
Fuel	$.0540
Lubrication	.0062
Repairs, labor and material	.0282
Wages, including motorman, conductor and porter, brakeman or trainman when same are employed	.0885
Cleaning car and equipment, including ice, coal, etc	.0058
Miscellaneous supplies, etc	.0042
Total average operating cost	$.1869

Using such cars a railway can operate a much more frequent service and can carry its passengers in up-to-date rather than obsolete equipment, offering a service, in short, which will enable it to hold its own against trolley lines or jitneys.

Gasolene and gas-electric locomotives have also been supplied, and one company, the Minneapolis, St. Paul, Rochester & Dubuque Electric Traction (Dan Patch Lines) conducting both an extensive freight and passenger business, uses solely gas-electric equipment.

It has also been proposed to introduce cheaper gasolene cars or railroad "jitneys" and one authority speaking before a recent meeting of the New York Railroad Club even proposed using large automobile trucks for this kind of service. Whether the railroad will ever be found that will care to operate such light equipment in front of heavy freight or passenger trains is still a question.

When the transportation man has become fully informed as to what the public wishes in the way of service he must next ascertain from his former experience what traffic will be covered by the service. It is then his task to work out the detailed schedule of each train so that each bears its proper relation to the rest. We must now consider what conditions affect the time of an individual train or of a group of trains.

The most important factor governing the time of an individual train is the number of stops it makes. It should be evident that in the case of through trains, only the essential stops must be made, that is, stops at the main cities which furnish an important through business. The second factor affecting the time a train can make is the amount of work necessary at intermediate stations. For an ordinary station stop but two or three minutes are required for passengers to board and leave the cars and for handling the baggage. Much more time than this is required, however, at important points where there is heavy traffic. At such places the train may be almost entirely emptied and reloaded and a large amount of baggage, mail and express handled. This requires considerable time. At division points the engines must be changed and the train carefully inspected. To change engines and test the air requires at least four minutes.

No train can maintain a maximum speed at all points between the stations at which it stops. That is made impossible by the natural limitations of grades and curves and by the speed restrictions established in the interest of safe operation. Practically every railroad establishes a maximum speed for its trains, applying over the entire railroad or division. Conditions also require that it establish lower maximum speeds over particular parts of the line. These restrictions in speed, however caused, must be allowed for in the time-table. That a locomotive cannot draw a train up a grade at full speed is only one of the limitations in speed resulting from grades. If the grades are so heavy that a helping engine is required, time must be allowed in the time-table for taking on the additional engine at the foot of the grade. Very often it is absolutely necessary in the interests of safety to limit the speeds of trains on down grades, particularly if there are sharp curves, reductions to speeds as low as 20 miles an hour being sometimes demanded on grades in the Rocky Mountains.

On many sharp curves it is considered good practice to restrict the speed of passenger trains, even though the curves may be constructed for high-speed operation. The existence of grade crossings, in well-settled communities especially, frequently requires the maintenance of low speeds. On four-track roads crossovers have a considerable importance. In Connecticut there is a ruling requiring that all trains must be run at a speed of 5 miles an hour or less before crossing from one track to another over any crossover shorter than No. 20. Decreased speed is almost invariably required in approaching drawbridges and usually in crossing such bridges. On the New Haven between New York and New Haven, a distance of 72 miles, there are six drawbridges. It will be seen that under such conditions, the decrease in speed from this cause is an appreciable item.

In addition to the above factors affecting the operation of individual trains, there are also factors affecting the relations of the trains to each other. In the first place, it is apparent that branch-line trains must be run in such relation to main-line trains that proper connections can be made. The main-line trains in turn should link up, in so far as possible, with the trains of connecting carriers. It is also highly essential that local and express trains on the line be so arranged as far as practicable that travelers from smaller points on the main line can make connections for express trains at the nearest large city or town.

On some heavy short-haul passenger roads—notably the Long

Island, the Central of New Jersey, and the New Haven—an arrangement is aimed at by which a train may start for a "group"—say at 4 P.M.—running express 40 miles, and then local the remainder of distance, perhaps 20, 30, or 40 miles. A second train follows at say 4.02 P.M. running express 20 miles and local 20; a third train at 4.04 P.M. runs local 20 miles. This may be repeated every 15, 30, or 60 minutes. In the morning hours, in the opposite direction the grouping is reversed; the short distance train starts first and runs in local, the second train starting 40 miles out runs in but halfway, the third train local to the 40-mile point—all reaching the final terminal close together.

The uniform time-table on suburban lines has much in its favor, and simplifies the problem for the commuter. In this arrangement trains are run during the greater part of the day, at uniform speed and time intervals, making the same stops. The passenger at A, for instance, gets a train toward the city at 7.09 A.M. and every 10, 15, 20, or 30 minutes as the case may be.

There are certain physical and operating limitations affecting the grouping of trains. A railroad has a certain trackage, and it is often impossible to increase the density of traffic over that trackage except at enormous expense, this being particularly the case with roads having a large mileage in thickly settled districts. This track capacity is, therefore, a limiting factor, for only a certain fixed number of trains can be operated over the congested district in a fixed period. This limitation is especially important on those roads which handle a heavy commuter traffic. Very often in such cases the number of trains which can be handled through the throat of the terminal is the maximum.

Another, but less serious, limitation is the number of engines and cars available for service at the busiest period of the day. This is less of a limiting factor because it is far less costly to buy cars and engines than it is to overcome the lack of sufficient track capacity. It must be considered that the same number of units of equipment must be at each point for service each day. It is not easy to arrange for the same number of trains each way each day, and the problem is complicated many times over in the case of commuter service where a rush into the city in the morning, a rush out in the evening and trains during the other hours of the day must be provided for. It is very essential, whatever the solution of the problem may be, that there be as little light engine and train mileage as possible, for such operation is always very expensive.

When a railroad is operated by electric locomotives or multiple unit cars, one very important limitation is the capacity of the power house. The latter may easily carry the regular load during the middle of the day, but a heavy commuter traffic will cause peak loads during so-called "commuter hours" about 8.30 in the morning and 5.30 at night which are far higher than the load during the rest of the day.

Such are the more significant factors entering into the construction of the time-table. Before turning to the problem of operating the trains provided for, it is worth noting that in conjunction with the time-table two other problems must be worked out, the assignment of engine runs and the assignment of crews. These cannot be said to affect the making of train schedules, but it is highly important that they be worked out in such a way that the greatest economy will result. In the case of engine runs there stand out two factors of importance: (1) there should be the highest possible mileage each day for each engine in service; and (2) there should be the least possible light mileage. When a road is short of equipment light movements are necessary, but in the majority of cases this is economically unjustified. In the assignment of crew runs, it is necessary that the least possible overtime should be paid and that there should be little constructive mileage.

CHAPTER XIX

PASSENGER TRAIN OPERATION

Passenger train operation in its first essentials means the operation of the trains provided for in the time-table with the maximum degree of safety and the greatest possible adherence to the schedules governing these trains. The problems of safe operation are considered in detail in Chap. XX. It is only necessary to point out here that there are four general requisites: (1) adequately maintained standard roadway and track; (2) standard equipment, properly maintained; (3) adequate signal facilities; and (4) proper supervision.

The other problem, that of adhering to the train schedules, is mainly a matter of avoiding and overcoming train delays. The question is decidedly complex, involving as it does all departments of the operating organization. Delays are chargeable to: (1) the maintenance of way department; (2) the mechanical department; (3) the signal department; and (4) to the transportation officers.

Delays due to defects in the roadway or tracks are not numerous. Such defects when they do exist are largely results of extraordinary weather conditions, such as washouts, landslides, bridges carried away by swollen rivers, etc., peculiar cases which cannot be controlled and in no way due to insufficient maintenance. Occasionally, however, there are broken rails; and sometimes delays are caused by derailments due to the track being out of line. This is covered in more detail in the chapter on Train Accidents. In general, the delays due to roadway defects are few, and the larger number can be avoided by proper maintenance. Occasionally work being done by the maintenance department, in the way of reballasting, rebuilding bridges, etc., does demand reduced speed over that part of the line affected, but such reductions in speed are rarely an appreciable source of delays.

The delays chargeable to the mechanical department fall naturally into two groups, namely, engine failures and car failures. The subject of engine failures could properly be made to cover an entire chapter, so wide is its scope. Though all these delays are charged to the mechanical department, there are many of them which are hard for the mechanical officers to avoid. Some of the failures result from broken parts due to defective castings and which could not have been detected by the inspectors when the locomotive was built. Failures which could have been avoided by more intelligent handling by the engine crew are properly to be charged to the mechanical department, however, when it is the specific duty of the road foreman to instruct the crews in the proper operation of the locomotive. Many failures are due to faulty maintenance or inadequate inspection. It is not out of place to point out at this point the folly of practising so-called economy in the way of reducing equipment maintenance or inspection. It has sometimes been the practice to allow locomotive and car maintenance to lapse a little during lean years, in the expectation that a prosperous year will follow and the equipment can be brought to standard again. It is possible to continue this practice for a short time without apparent effect, but in time equipment failures will begin to increase to a marked extent. The result will be accompanying dissatisfaction on the part of the traveling public. It is far better that the net operating income should show a decrease than that the service should deteriorate. In the one case, although the price of the stock may drop a little, the road retains its reputation for safe and adequate service. In the other, the price of the stock is held up by a mere paper showing, while the public becomes dissatisfied with the service. Which is the better result, it is not hard to perceive. It is a first essential in train operation that engines be maintained to proper standard and that they be frequently inspected. In no other way can delays from this source be avoided and proper service given.

The largest number of failures due to defects in passenger cars are chargeable to hot boxes. Delays sometimes result from damaged drawbars, but these are not frequent in passenger service. Hot boxes are sometimes due to defects in the brasses, but the majority of them can be avoided if the journals are properly packed and there is adequate inspection at terminals and important intermediate points. Here again the practice of reducing the amount of inspection proves false economy and brings about poor results in the end.

The third class of delays includes those chargeable to signal failures. Delays of this character are rare, as the signals, especially the best types of automatic signals, are remarkably efficient.

If a railway is electrically operated, another type of delays is introduced in the form of failures in the transmission system. If the direct-current system is used, there are three classes of possible failures: (1) in the power plant; (2) in the substations; and (3) in the third rail (if that system is used) or in the overhead contact if that is the type. If alternating current is used, there may be failures in the power house or in the overhead transmission. A power-plant failure is a very serious matter as trouble of this character will tie up the entire electric zone. As a matter of fact, there are very few, if any, difficulties of this kind. On the New Haven, delays due to line failures have been at times serious, though recently the possibility of several of them has been practically eliminated by improvements in the construction of the transmission line. Some delays of this kind are inevitable, especially those due to insulator failures. They can be reduced to a minimum, however, by close inspection and by prompt work on the part of the repair trains which are used solely to repair the line. The method of locating grounds has been excellently worked out, so that the train can be sent at once to the proper point. Here, just as in the case of steam operation, an unceasing watch must be kept over the parts affected. A close coöperation must exist between all the departments interested and constant study made of the methods of improving the service rendered.

Transportation delays are those due rather to errors in organization and execution than to failures of equipment. They are very often directly chargeable to the element of human fallibility.

Among the most important of this class of delays are those occasioned by heavy work at the originating terminal or at stations along the line. The handling of baggage, mail, express and milk is a frequent source of delay, especially in the summer months when vacationists are on their way to or from the summer resorts. It takes the most expert organization to prevent delay at the stations where the larger part of the work is concentrated. Even with two or three men in the baggage car and an adequate force at the station, there is but a certain amount of work that can be done in the time allowed, and, if the traffic runs more heavily than anticipated, delays are inevitable. In such cases, however, it is frequently found advisable to run special trains for this service alone. On holidays in the summer when traffic is very heavy it is not uncommon for a railway to run special baggage trains as sections of regular trains. This helps to eliminate the delays which may possibly arise from heavy movement of baggage.

The conditions surrounding the handling of express, mail and milk are similar. Almost all roads handling large quantities of express operate regular express or express and mail trains to relieve the regular passenger trains. When there is strenuous competition for carrying the mails, the trains carrying mail exclusively may often have faster schedules than many of the important through passenger trains. The handling of milk is determined not only by the amount presented for transportation, but by the character of the tariffs governing the traffic. If the milk is carried under a freight tariff based upon weight it is considered freight traffic and is handled on fast freight trains. If it is charged special rates and carried in passenger trains, the handling of it becomes a branch of the passenger service. Trains of milk cars are very often run in the same manner as express or mail trains.

The time required to change engines, to coal and water engines, or to set out and add cars is always an important consideration. If the train schedule is a fast one, only a minimum amount of time can be taken to do this work and to do it properly. Delays will surely occur if there is not coöperation between the engine house and transportation forces. These delays will result if the engine to be placed on the train at the intermediate point is not ready to back onto the train as soon as the other engine has pulled away from the train or if the switch engine is not ready to couple onto the rear and to set off the coach or dining car which is to be removed It is likewise true with the work of the inspectors. The train can maintain its schedule only when all the forces at intermediate points are well organized and working together.

Many transportation delays, if such they may be called, are chargeable to the despatchers. It is one of the first essentials of train operation that the movement of freight should not cause delays to passenger trains. It is the duty of the despatcher to see that if a freight train is on the line it is kept out of the way of the passenger trains. A single freight train, indeed, in a section of heavy commuter traffic during the morning rush may disorganize the entire commuter schedules.

A great many delays are due to trains ahead. It is one of the problems of the despatcher to send trains in the rear around a disabled train, if it is possible to make such detours. If the trouble occurs on a two-track line, the delayed train may be taken into a siding where the others may pass around it. On a four-track line the following trains may be given instructions to cross over and pass around the delayed train or trains. By these and other means, the delay may be limited to but one or two trains.

One of the most difficult problems to solve is a derailment or similar difficulty on the interlocking of a large terminal. If the derailment occurs in the throat of the approaches, the entire terminal may easily be completely tied up for a considerable time. A derailment occurred on the interlocking of one large and exceedingly busy terminal at 5.15 P.M. immediately preceding the outbound commuter rush. Although the train involved was out of the way in 15 minutes, the entire service was so affected that trains in and out of the terminal were not running on time again until 8 o'clock. The possibility of such delays can be prevented only by not placing too much dependence on one set of cross-overs at the most important part of the terminal approaches.

In addition to the delays which have just been considered, delays which for the most part can be avoided by close supervision, coöperation and efficient methods of operation, there are other delays which cannot be avoided under the most skilful management. These are such as are due to heavy storms of snow or rain, those due to blockades, washouts or landslides which could not be foreseen in time to allow the railway to cope with them. These delays will occasionally occur and no amount of work or study can prevent them.

We have now considered the operation of the trains over the road and the efforts which must be made to run them according to schedule. The other factor which is now to be considered deals with what perhaps might be termed the interior operation of the train. It has to do with the work of the conductors and trainmen, and their dealings with their patrons.

The passenger conductor, with the possible exception of the station agent, can do more to popularize or unpopularize the road for which he works than any one man. The success of an enterprise is dependent upon the good will of its patrons. The conductor should, therefore, bear in mind that his duties are of the most delicate and responsible character, and that he controls the conduct of the trainmen and is responsible for the passengers committed to his care. He should remember that his conduct toward his passengers demands unusual judgment, tact and courtesy, and that, in short, the safety of his train, the comfort of his passengers and the reputation of his road are dependent upon his discretion and care.

If there is any case in which a conductor must exercise his entire stock of tact and judgment it is in controversy with passengers who decline to pay their proper fare or to present the proper tickets. He can usually distinguish those who have no intention of evading a just payment and those who simply wish to defraud. A passenger who refuses to pay, or one who is rough or abusive, should, nevertheless, be treated with courtesy even if it is difficult. Should it become necessary for any cause to eject a person from a train there must be no needless force or violence. In no case should there be ejectment save at a station or before the conductor has explained as pleasantly as conditions may permit, and so that other passengers may hear, just what his duties are. The names and addresses of passengers sitting near by should be obtained so that they may be called upon as witnesses in case a suit is brought. It is not advisable to eject in other than extreme cases and then it should be done only as a last resort.

The general conduct of passenger train employees will go further toward popularizing or condemning a transportation line than any other one thing. There are many little things not included in the rules which they can do and certain other things too frequently done which they should not do which help secure the best advertising the railroad can have, namely, the commendation of its patrons and favorable reports to their friends. A chairman of the Massachusetts Railroad Commission once called attention to the many little failures and irregularities under the general head of "Ethical Efficiency" and enumerated the inharmonious dressing of trainmen who often adorn themselves, with red, yellow or green ties to accompany their blue uniforms, dress with rusty looking shoes, or wear caps improperly balanced on poorly balanced heads, etc. Similarly, attention might be called to the use of tobacco or chewing gum, unnecessary or lengthy conversation with other employees or passengers; familiarity; the turning of seats for other than invalids, old persons or women accompanied by children; the failure to return seat backs to their proper position; eating lunches in coaches; the reading of books and papers; loud talking; excitable movements; the discussion of railway occurrences; political or religious arguments; permitting toilets, water coolers and other like accessories to be unclean or out of order, and making no report to that effect; permitting passengers or unauthorized employees to ride in baggage, express or mail cars or upon platforms; permitting employees to occupy seats while revenue passengers are compelled to stand; improper attention to the heating and ventilation of cars; using lavatories in sleeping and chair cars, often debarring passengers while so doing; leaning against baggage trucks, cars or anything else; or standing beside the train with hands in one's pockets.

Among things that count also is the manner of announcing stations. Care should always be taken not to announce a station when it is possible that an intermediate stop may be made. If such be made unexpectedly, announcement should be made immediately as follows: "This is not the station stop;" and trainmen should take care to guard the doors so that passengers may not attempt to leave the cars and thereby run the risk of injury. When station and other announcements are to be made the doors should be closed to keep out the noise and the speaker should speak clearly with his face toward the passengers. The announcement should be made from each end of the car and names pronounced correctly and distinctly articulated. Trainmen should be impressed with the fact that the prime object in making announcements is to convey information and that they should therefore be made distinctly and at the same time without unnecessary annoyance. Junction points and principal stations for which change of cars may be necessary should be named. Conductors, when they are collecting tickets, should inform the passengers if such change of cars is necessary. When trains are announced in waiting rooms, the route, destination and principal stations should be included.

Turning the seats for passengers during the day or early evening—even when the car is not filled—unfortunately tempts many persons to put their feet upon the seat cushions often with resulting inconvenience later to wearers of valuable gowns. One large railway allows conductors to use their judgment about permitting seats to be turned but requires them to see that passengers are careful not to soil the cushions.

As a matter of convenience both, to passengers and employees sellers of newspapers, confectionery, and tobacco should not be permitted to enter a train at a terminal within the last two or three minutes before its departing time, and unless they are to accompany it, on the other hand, they should be required to leave the train a minute or more before it starts. The neatness and cleanliness of these employees is essential. They should be properly uniformed. It is their duty, and they may often need to be reminded of it, to be polite and courteous to the railroad's patrons. Under no circumstances should they be allowed to place articles or papers on seats or in the laps of passengers. Ordinarily train boys are restricted to one passage through the train in every 15 miles. They are usually limited to four announcements in a low tone of voice in each car and must never importune or annoy patrons.

It goes without saying that conductors and other employees should never attempt to influence passengers directy or indirectly in favor of any particular hotel.

In no field of operation does a railroad come in closer contact with the general public than in connection with suburban service. The thousands of persons who use the trains twice a day year in and year out get to know the railroad very intimately. They appreciate convenient schedules, regular trains and punctual service, clean cars, sufficient seats and courteous employees and a railroad with satisfied commuters will find it has made some very loyal friends. If these advantages are lacking, on the other hand, loud and angry protests are a sure result. Commutation rates are among the lowest charged for any class of passenger business and the service, because of its inherent peculiarities is among the most expensive to handle. It is most essential, nevertheless, that railway officers should give the closest attention to the handling of commuter traffic.

The average commuter is a very respectable high-class citizen. There always is a small but vigorous minority among commuters, however, that is heard from long, loud and frequently. It is, perhaps, natural that the casual traveler who uses (and pays for) the highest class equipment going long distances is much less disposed to criticize and find fault than the regular twice-a-day, short distance rider from whom a very low fare is received—and frequently, if not usually, a fare that does not directly compensate for the service rendered.

The public should criticize fairly and reasonably. All just and intelligent criticism is beneficial alike to carrier and patrons. A line must be drawn between this and mere fault-finding and obstruction. The man who complains to the higher officers—or through anonymous or fictitiously signed letters to the newspapers—that there were no vacant seats in a particular train, when as a matter of fact he could easily have found them had he passed through to a second or third car only serves to discredit railway patrons as a whole. There are too many complaints of this character made by people who, coming late, in a party, were unable to find two, three or more seats together. We have, too, the unreasonable or unreasoning persons who will be satisfied only with seats on the shady side of the train or on the river side where the line parallels a river.[1] Similarly, the man who declines to pay his fare because there is no vacant seat in that particular car—possibly it is the smoking car—even though there may be seats in other cars, confers no lasting good and only serves to ruffle the often sorely tried patience of the trainmen and to annoy respectable and reasonable travelers.

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[1] This is met with on the New York Central between New York and Albany.

The action and conduct of train employees calls for the unusual. They must meet these contentions with "firmness, frankness and forbearance." One of the great difficulties sometimes encountered, however, is the assumption and assertion of the exalted ego of the railway employee who permits the adornment of his person with a few brass buttons to necessitate letting out his hat band. To overcome this much detailed attention and supervision on the part of the officer is essential. The latter must not be "so engrossed with the routine of his work that he cannot catch the inspiration of an ideal which is not expressed in blue prints and time-tables." Real complaints should be met in the proper spirit and "nipped in the bud." In this the manner in which the officer or employee receives a complaint or complainant may mean considerable.

The commuter who writes a letter to the management every time his train does not reach its destination exactly on time, is met more or less frequently. A certain case of which the author has knowledge will serve to illustrate.

Unfortunately, the train on which this complainant rode to his place of business was not making a very good record and the commuter, who was evidently a gentleman of the aggressive type, inaugurated a series of daily letters to the general manager, advising the latter just how many minutes of his time were lost to his business on account of the lateness of the train. These letters, which were comparatively mild at the start, gradually increased in virulence until Mr. Commuter was finally telling the G. M. that he had better resign his position in favor of some one who knew something about railroading, etc.

The records given by the commuter of the lateness of the train never corresponded with those of the road, the road's records always showing the train much closer to being on time than the complainant alleged. When the commuter's attention was directed to the discrepancy, he stoutly maintained that his time was correct. Finally, a trainmaster, with a watch accurate to the second, was detailed to record the exact time the train came to a stop. This he did for a number of succeeding days. On matching his record with the figures given by the commuter, it was found that on a number of days when the commuter reported the train several minutes late, the trainmaster's record showed it exactly on time.

It was never learned whether the commuter's watch was of the dollar variety or he took his time from the public clock on the outside of the building, which was several minutes walk from the point where he left the train.

Complaints are continually being made because railways cannot accept and forward or attempt to forward baggage in an unreasonably short time before a train departure. A recent complaint was based on the inability to get a parcel out of a parcel room quickly enough to allow the complainant to catch a train which was just leaving; it was clearly shown that the passenger could not have boarded the train, even had he not lost a moment at the parcel window. An instance is recalled where a patron lost his train because he took his time from the town clock; the complaint was vicious, and bristled with remarks about "inefficiency," "incompetency," "monopoly," etc. Another case producing the usual communications to the railway's officers was that of a citizen, who started in an automobile at the last moment and missed connections with the train he intended to take, because another automobile ahead became disabled, and blocked his approach for a few moments.

Strange though it may seem, improved service and equipment are frequently prolific breeders of complaints. Car lighting is one example. The oil lamp in passenger cars when it was introduced was considered splendid illumination, in that it surpassed the candles. When Pintsch gas came into being, complaints as to lighting by oil lamps begun to multiply. Acetylene gas gave a brighter light; a railway's enterprise in introducing it was partly rewarded by an avalanche of "kicks" at the cars still lighted by Pintsch gas. The cars with the older lighting system, of course, were not so bright, but they could not be obliterated as if by magic. Progress is again being "rewarded" by some few fastidious travelers as the electric light is being introduced. The rather rapid introduction of steel cars induces "knocks" relative to the wooden cars. Were the complaints made in a courteous manner in such instances, no exception could be taken, but that is not always the case. The one redeeming feature in the matter is the appreciation of the progress made by the railways shown by the vast majority of the traveling public. The "kickers" are rarely more than a very small minority.

The handling of dogs, although sometimes an important revenue producer,[1] is frequently a very fruitful source of trouble. If the dog is permitted or "sneaked" into an ordinary coach, he will probably cause annoyance and is very likely to frighten nervous passengers. It is a remarkable fact that a woman will never believe her pet dog to be anything but perfection in every respect—and the trainman's worst combination to deal with is a woman with a dog. In the ensuing discussion, all of God's angels would be unable to convince the woman that between the trainman and the dog, the trainman is not the greater brute. If the dog is slipped into a car with other passengers, trouble immediately ensues and rules—usually—have been violated or ignored. No one ever succeeded

[1] The Baltimore & Ohio in the year ending June 30, 1915 handled 40,000 dogs (at 25 cents each giving a total revenue of $10,000) without a claim for loss or injury.

in explaining to a woman that her dog must go in the baggage car or stay at home without such explanation having been made in "a rude, discourteous and abrupt manner." The baggage master, too, has his troubles with dogs; instances are recorded where a difference of viewpoint resulted in a small, but vigorous, representation of the European battle-front.

Passenger train conductors very often have to supervise the moving of detached passenger cars. If the cars are occupied, or if the cars on the tracks onto which they are to be shunted are occupied, the engine should invariably be attached and air brakes coupled. Many roads require in these cases, where any of the cars are occupied, that a stop be made at a point 40 or 50 ft. from the cars which are to be attached.

Adequate rear-end protection of trains is partly provided for by space or time interval rules and partly by block signaling. The flagman, however, is still at hand and the enforcement of obedience on his part of plain simple rules, requiring perhaps too little exertion on his part, is one of the many complex problems of the operating officer. Standard Rule 99—varying slightly on different roads to meet local conditions—contains all that needs be said. It is surprising, nevertheless, to observe the number of flagmen who are not familiar with the practical common-sense rules of their business. There are too many who know no better than to obscure their red lights by putting white lights in front of them. In like manner, a flagman at critical moments often will wave his light so viciously as to diminish greatly the size of the flame. How many flagmen use their gray matter sufficiently to lead them to place a torpedo on each rail at opposite points so that there may be one sound with two explosions during a snowstorm or when similar unusual conditions exist whereby one torpedo may be shifted or the engineman may be shut up in his cab so it may be difficult to hear? There are too many flagmen who do not properly unfurl their flags and too many others who find it preferable to carry a pocket flag instead of the prescribed staff flag.

The ordinary or normal passenger train service, after once having been arranged on a conservative and practical basis, should conduct itself, barring accidents or the occasional "man failures" which no one can foresee with any degree of certainty. The real problem is the "mass-movement" so-called, and especially when an unusually large number of persons must be taken care of in a short period of time, thereby demanding facilities and equipment many times in excess of ordinary requirements. A neat illustration of this kind was that arranged and executed by the New Haven on the occasion of the Harvard-Yale football game at New Haven, Conn. on Saturday, November 21, 1914, this being also the opening of the Yale Bowl which on that day was used to its full seating capacity of 70,000 persons. On this occasion the New Haven in 24 hours carried 37,500 passengers to New Haven for the game in addition to its regular travel, 33,468 of the total during a four-hour period. The 33,468 was divided as follows: 27 trains from New York with 17,800 passengers; 18 from Boston, 7,474 passengers; 5 from Springfield, 3,997 passengers; 3 from Hartford, 1,254 passengers and 12 other trains with 2,943 passengers. Between 5.20 P.M. and 6.20 P.M. 18,000 passengers were moved out of New Haven—300 a minute; and between 4.40 P.M. and 7.15 P.M., 33,000 passengers, or 220 a minute. During this rush there were handled into New Haven 65 trains, 43 of them specials and all heavy—ranging from 10 to 12 cars each. Of the 43 special trains to New Haven, 16 reached their destination ahead of time, 18 were four minutes late or less and the time lost aggregated 166 minutes or an average of three and one-half minutes a train. Between 10.10 A.M. and 1.35 P.M. a train was handled and put away at New Haven every three minutes and nine seconds.

The arrangements made in advance for handling this mass-movement —one of the heaviest in this country for the short space of time and for similar distances—may be of interest. A pamphlet was issued several days in advance and placed in the hands of each interested employee. On the cover of the booklet it was stated that the contained schedules and instructions conferred no track running or time-table rights; that work and freight train service must not be permitted to interfere and that while punctuality of trains and comfort of passengers were desirable ends to be attained, nothing must be done that might in the slightest degree interfere with the safe handling of trains and passengers.

The first page of the pamphlet contained under the head of "General Instructions" detailed information regarding; ticket and cash collections; the designation of trains by special symbols (thus, NC represented the third special from New York, BD, the fourth special from Boston, etc.); the location of special parcel rooms and information bureaus; the methods of reporting the number of passengers carried; the restriction of freight-train runs and work train limits. It was ordered that drawbridges be kept closed within 15 minutes of each train except in case of extreme emergency; and towermen were cautioned to handle carefully the levers in interlocking towers and the block-signal apparatus in blocking towers. Instructions were also included telling enginemen to get clear of the main track on the first indication of trouble with their engines to avoid detention to other trains and ordering freight trains to remain in yards or on sidings during the period of heaviest movement. The instructions also related to the signal maintainers and repairmen to be stationed at interlocking plants en route to render prompt assistance if required; the thorough inspection of all electrical and other plants on the day previous; the cautious approach of trains at congested terminals, and the stationing of flagmen at Stamford for protection of trains and to avoid detentions.

The next page (3) covered in detail the five regular trains, the 16 "regular" specials and six "extra" or emergency specials to leave New York for New Haven between 8.16 A.M. and 11.15 A.M. giving for each train its symbol number, the number of cars, the time of departure from New York, Stamford, South Norwalk and Bridgeport and the arriving time at New Haven, and including also footnotes relative to operating details. This was followed by detailed make-up and movement schedules of Special C, from New London to New Haven; Specials BD, BE, BF, BG, BH, BI, BJ, BK, and BM, from Boston via the Shore Line; Specials BO, BR, and BS from Boston via Putnam and Willimantic; Specials SA, HA, SB, SC, SD, HB, WA, and D from Boston via Springfield, from Hartford and Waterbury according to symbols, Special D being a train of private cars from the Pennsylvania Railroad via Poughkeepsie Bridge. There followed detailed instructions for handling engines—both steam and electric—at New Haven; a list of classes of engines to be used—whether steam or electric, and where changes were to be made en route if any; and a statement of 15 points where emergency engines were stationed; one each at 11 places and two each at four places—a total of 19 emergency engines headed toward New Haven during the forenoon and away from New Haven during the afternoon. Next followed instructions designating where coal and water were to be taken, and the kind of coal for each engine. This was in turn followed by a statement of extra cars to be added to regular trains; then the detailed handling of dining cars which, of course, varied from normal. The location of wrecking trains at Stamford, New Haven, Midway, Providence, Readville, Readville Transfer and East Hartford was next provided for, heading toward during the inward movement and from New Haven during the return movement—all manned and under steam. The position of emergency engines, and direction headed was similarly arranged for. At New Haven, two wrecking trains were in readiness, one headed east and one west.[1] The lighting of cars and placing of cars in advance, to meet the requirements, was carefully covered, followed by rules relating to the number of car inspectors at designated points with notes dealing with the kind of material and the special assignment of air-brake men, engine house foremen, helpers, etc. A definite location was then given for certain officers; *e.g.*, at New Haven, an assistant mechanical superintendent, the general car inspector, a road foreman and the superintendent of shops; at Cedar Hill, the master mechanic; at Stamford, the electrical superintendent, an assistant mechanical superintendent, the master mechanic, an assistant mechanical superintendent, the master mechanic, an electric road foreman and a steam road foreman; at Cos Cob, the superintendent of power service; at New York, a road foreman and the general car inspector, and at other designated points, the master mechanic and the road foreman. A terminal time-table for New Haven followed covering all trains in and out between 9.33 A.M. and 9.28 P.M., giving train numbers (divided in columns for eastward and westward) arriving time, departing time, track on which handled and under "Remarks" description of the train and its handling at the terminal. This was followed by detailed instructions for handling at New Haven, reference being made in particular to switchmen, flagging, lost articles on trains, engine movements, etc. On the last two pages of the pamphlet were the full instructions for handling electric engines for regular trains and specials.

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[1] The undertaking may be more fully appreciated when it is understood that all the regular passenger and freight service of the road was carried on as usual, with the exception that freight trains were held back some three hours during the heaviest movement in each direction, more as a matter of precaution than actual necessity. The freight terminals at New Haven were largely given over to passenger service. Freight trains, therefore, were less "in the way" out on the open road, than they would have been lying back in the terminals.

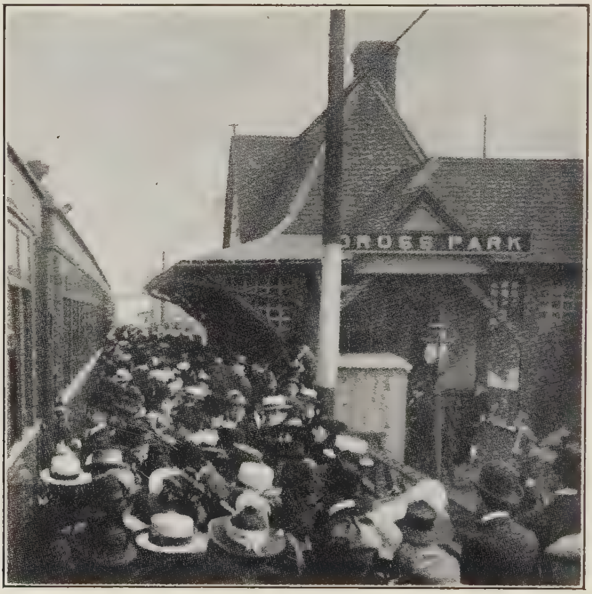

Fig. 205.—What one station had to contend with during the Chicago strike.

Each passenger going to New Haven was handed, en route, a circular telling him where his train would be found for the return trip and giving the track number, departing time, and other information. There were also included, a diagram of the New Haven Terminal, a plan of the Yale Bowl and a map of the city showing the routes between the station and the bowl.

There is nothing which can be compared with the New Haven's football movement except a record of one of the mass-movements incidental to the European war, although even there, the conditions differ greatly, because in that emergency all train movement—in fact *everything*—is subordinated to the movement of troops. In August, 1914, the British roads were given 60 hours to make ready for despatch to Southampton, the port of the departure, 350 trains of some 30 cars each. The roads were ready, however, in 48 hours. During the first weeks of the war there were unloaded at Southampton during 14 hours of practically each day, an average of 73 trains, including a stop alongside the steamship and the unloading of a full equipment of guns, ammunition and horses. The trains arrived at intervals averaging 12 minutes, and nearly every train came through on time.

The railways serving Chicago made a wonderful record, at the time of the traction strike in that city lasting from Sunday, June 13, to the evening of Wednesday, June 16, 1915. The steam railroads out of Chicago normally carry about 125,000 suburban and 75,000 through passengers into and out of the city each day. During the first two days of the strike, they handled about 625,000 suburban passengers alone, or five times their regular business. This work was done almost without warning and there was no accident of any kind.[1]

The Illinois Central normally handles about 40,000 suburban passengers a day, requiring, to take care of this traffic, 279 trains. During the strike it increased this service to 311 trains each day, a total of 622, and during the three days of the strike, it carried 678,640 persons; 248,800 on Monday, 252,650 on Tuesday and 177,620 on Wednesday. The entire movement was handled without a derailment or an engine failure.

The Chicago & North Western normally handles 50,000 passengers a day. During the second day of the strike it handled 194,300 in 288 trains between 6.00 A.M. and midnight in addition to 93 regular through trains to and from points outside the suburban zone with about 14,000 passengers.

These two roads handle a larger suburban business out of Chicago than any of the other roads. The figures, however, are typical of them all. The entire performance is merely another indication of what railway men can do in case of emergency.

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[1] See Fig. 205.

CHAPTER XX

ACCIDENTS AND THEIR PREVENTION

There are few subjects connected with railway operation that have received more attention in the past few years than accident prevention. The railroads and the public have both given the matter considerable thought; and there can be no doubt that immeasurable good has been done.

The record of the American railroads as to the number of persons killed or injured in railroad trains or on railroad property is not an enviable one. It may be shown that a very large proportion of the persons killed are trespassers (5,471 of a total of 10,302 in 1914) and that adequate enforcement of the laws would eliminate a large part of this danger.[1] If we leave out of consideration entirely the element of trespassing, however, we shall still find that the number of employees and passengers killed and injured is much in excess of that in the foreign countries where there are modern railway systems. The record of the American railroads is improving, but it cannot yet compare with those of the English or German railroads, unless it be possible that the very special exigencies of transportation under war conditions may have disturbed these records for the time being.

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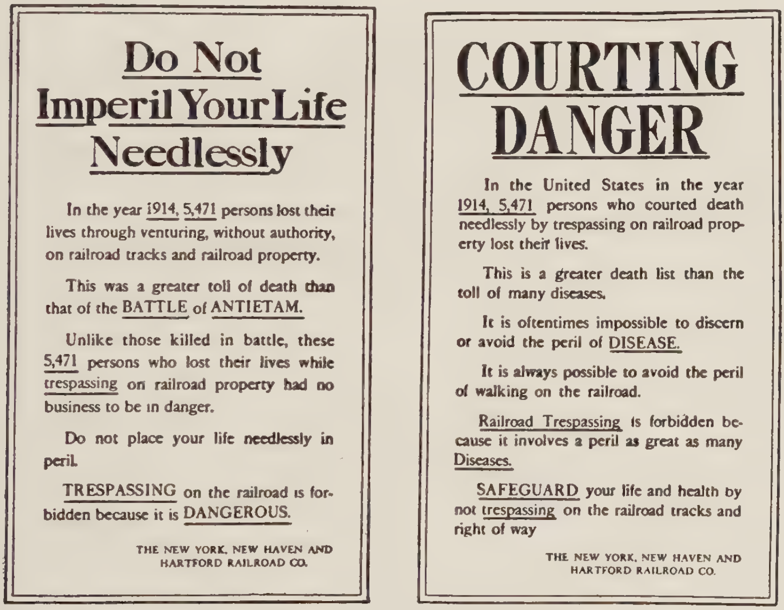
[1] The Publicity Department of the New Haven recently issued the following statement: Railroad managers are spending a good deal of thought, effort and money in preventing what is technically known as trespassing—that is, preventing pedestrians from using railroad tracks as streets, alleys or country roads. There were 5,558 railroad trespassers killed in the United States during 1913—nearly 14 times as many as all the passengers killed during the same period. From 1901 to 1910, 50,025 railroad trespassers were killed in the United States and 53,427 injured, while only 4,434 were killed and 1,315 injured in the United Kingdom during the same period. In England the law governing railroad trespassing is strictly enforced, while in all but a few states of the United States it is generally not enforced. England has since 1868 prohibited any unauthorized person to be upon railroad property under penalty of $10 fine. France forbids any person not in the railroad service to enter upon its right of way except with a permit signed by a railroad officer. Violations are punishable with fines up to $579 and jail up to a month for each offence. In Germany, the penalties range up to $25. The European public has become very generally educated up to keeping off the right of way. In Canada there is little trespassing. Many persons might object to comparing the United States with its vast area to Great Britain, but there can be no such objection raised when comparisons are made with Canada. Canada fines trespassers up to $50 or imprisons them for two months. An official of an American railroad that operates partly in Canada says: "The law in Canada is very strictly enforced. The result is that we are not burdened with the trespassing evil in Canada." . . .

Various reasons have been advanced to explain American discrepancies in regard to accidents. It is a grave question we must face, if we are forced to admit that the American railroads are less safe than those of foreign countries. We are justly proud of our transportation system and the service it performs. That safety of operation is first and always the fundamental necessity of railroading is an axiom which all will readily admit. How, then, are we to justify or extenuate the facts?

It is usually claimed that the American propensity for taking chances is an important element in the problem. There is no doubt that much can be made of this argument. The consideration of "Safety First" has brought to light many practices which, it is to be wondered, are not productive of more accidents than actually do take place.



Do Not Imperil Your Life Needlessly

In the year 1914, 5,471 persons lost their lives through venturing, without authority, on railroad tracks and railroad property.

This was a greater toll of death than that of the BATTLE of ANTIETAM.

Unlike those killed in battle, these 5,471 persons who lost their lives while trespassing on railroad property had no business to be in danger.

Do not place your life needlessly in peril.

TRESPASSING on the railroad is forbidden because it is DANGEROUS.

THE NEW YORK, NEW HAVEN AND
HARTFORD RAILROAD CO.

COURTING DANGER

In the United States in the year 1914, 5,471 persons who courted death needlessly by trespassing on railroad property lost their lives.

This is a greater death list than the toll of many diseases.

It is oftentimes impossible to discern or avoid the peril of DISEASE.

It is always possible to avoid the peril of walking on the railroad.

Railroad Trespassing is forbidden because it involves a peril as great as many Diseases.

SAFEGUARD your life and health by not trespassing on the railroad tracks and right of way

THE NEW YORK, NEW HAVEN AND
HARTFORD RAILROAD CO.

FIG. 206.—Warnings to trespassers.

Another American characteristic which may be given as a reason—though by no means a justification—for the larger number of accidents is the relative lack of respect for authority and the general laxness of discipline in many phases of American life. The noted responsiveness to discipline of the German people, particularly noticeable in the case of railway employees, does much to sustain the splendid record of performance of the German railroads. In that country, to pass a signal indicating stop is punishable not only by dismissal from the service as in this country, but by imprisonment. This is no argument for a like penalty here, but there is little doubt that the existence and rigid enforce-

Summary of Casualties to Persons in Railway Accidents for the Years 1913 and 1914, and Annual Figures Since 1899[1]

	1913		1914	
	Killed	Injured	Killed	Injured
Passengers—				
In collisions	119	3,902	31	3,016
Derailments	22	3,513	40	2,941
Other accidents to trains	....	100	....	36
Other causes	195	6,892	152	7,047
Total passengers	336	14,407	223	13,040
Employees—				
In collisions	302	3,935	231	2,660
In derailments	244	2,806	217	2,391
In other accidents to trains	51	1,311	18	780
In coupling accidents	195	3,360	171	2,692
Overhead obstructions, etc	96	1,844	90	1,498
Falling from cars, getting on or off cars, etc	575	16,157	513	14,740
Other causes	1,543	29,338	1,325	28,161
Total employees on duty	3,006	58,751	2,565	52,922
Total passengers and employees on duty	3,342	73,158	2,788	65,962
Employees not on duty—				
In train accidents	12	146	5	117
In coupling accidents	....	1	....	2
Overhead obstructions, etc	2	9	3	5
Falling from cars, etc	65	408	54	370
Other causes	283	614	265	603
Total	362	1,178	327	1,097
Other persons, not trespassing—				
In train accidents	9	110	9	148
Other causes	1,279	5,932	1,298	5,827
Total	1,288	6,042	1,307	5,975
Trespassers—				
In train accidents	90	174	75	178
Other causes	5,468	6,136	5,396	6,176
Total	5,558	6,310	5,471	6,354
Total accidents involving train operation	10,550	86,688	9,893	79,388
Industrial accidents, not involving train operation	414	113,620	409	113,274
Grand total	10,964	200,308	10,302	192,662
1912	10,585	169,538	....	....
1911	10,396	150,159	....	....
1910	9,632	119,507	....	....
1909	8,722	95,626	....	....
1908	10,188	104,230	....	....
1907	11,839	111,016	....	....
1906	10,618	97,706	....	....
1905	9,703	86,008	....	....
1904	10,046	84,155	....	....
1903	9,840	76,553	....	....
1902	8,558	64,662	....	....
1901	8,455	53,339	....	....
1900	7,865	50,320	....	....
1899	7,123	44,620	....	....

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[1] Interstate Commerce Commission Annual Report for 1914. This and the four following tables are also to be found in Chapter XII of the Railway Library for 1914, published by the Bureau of Railway News and Statistics, Chicago.

ment of laws establishing such punishment has a distinctly wholesome effect.

It is also to be pointed out that the trains on this side of the water are much heavier and that the wear and tear on both roadbed and rolling stock is much greater. The operation of heavy passenger trains at high speeds cannot but increase the chances for many kinds of accidents. In foreign countries, as a rule, trains are much lighter, though operated at as high or higher speeds.

PASSENGERS CARRIED ONE MILE TO ONE KILLED

Year	Passengers killed in train accidents	Passengers carried one mile	Passengers carried one mile to one killed
1914	71	35,129,269,000	494,778,436
1913	141	34,447,197,000	244,306,362
1912	114	33,510,673,000	293,953,272
1911	94	33,201,694,699	353,209,518
1910	179	32,338,496,329	180,661,991
1909	102	29,452,000,000	288,745,100
1908	148	29,082,836,944	196,505,648
1907	367	27,718,554,030	72,802,600
1906	137	25,167,240,831	183,702,488

It is a fact, however, that traffic in England and Germany is more dense than here. Though ton mile density is much greater here than in any country in the world, the train miles per mile of road are less than in England and Germany owing to the enormous passenger traffic in

SUMMARY SHOWING NUMBER OF TRAINMEN KILLED IN RAILWAY ACCIDENTS, 1900 TO 1914, WITH RATIO TO NUMBER EMPLOYED

	Trainmen	Trainmen in yards	Yard trainmen switching crews	All trainmen	Number of trainmen for one killed
1900	1,396	....	....	1,396	137
1901	1,537	....	....	1,537	136
1902	1,507	....	....	1,507	135
1903	2,021	....	....	2,021	123
1904	1,181	487	488	2,156	120
1905	1,155	386	493	2,034	133
1906	1,360	400	575	2,335	124
1907	1,507	459	630	2,596	125
1908	1,097	362	496	1,955	150
1909	789	270	313	1,372	202
1910	1,056	325	474	1,855	169
1911	905	313	490	1,703	182
1912	917	265	481	1,663	192
1913	869	304	527	1,700	197
1914	738	260	479	1,477	210

those countries. Even on the New Haven, the Boston & Albany or the Long Island which have the densest passenger traffic of any roads in the United States, the density is considerably less than in either of the two European countries in question.

The Interstate Commerce Commission in commenting on the year's accident record in its 1913 annual report expressed the following significant opinions:

> During the year ending June 30, 1913, a total of 76 train accidents were investigated by the Commission. These accidents comprise 51 collisions and 25 derailments, and caused the death of 283 persons and the injury of 1,880 persons. The collisions investigated were responsible for 221 deaths and 1,174 injuries, and the derailments caused 62 deaths and 706 injuries.
>
> The Commission again is compelled to note the exceedingly large proportion of train accidents due to dereliction of duty on the part of employees. Fifty-six of the accidents investigated during the year, or nearly 74 per cent. of the whole number, were directly caused by mistakes of employees. These mistakes were of the same nature as those noted by the Commission in its last annual report, namely: disregard of fixed signals; improper flagging; failure to obey train orders; improper checking of train register; misunderstanding of orders; occupying main track on time of superior train; block operator allowed train to enter occupied block; despatcher gave lap order or used improper form of order; operator made mistake in copying order; switch left open in the face of approaching train; excessive speed; failure to identify train that was met.
>
> These errors are exactly the ones which figure in the causes of train accidents year after year. Their persistence, leading always to the same harrowing results, points inevitably to the truth of one or the other of the following alternatives: Either a great majority of these deplorable railroad disasters are unavoidable or there exists a widespread lack of intelligent and well-directed effort to minimize the mistakes of employees in the operation of trains. It is not believed that all those accidents which are caused by the mistakes of employees are unavoidable. It is quite true that man is prone to error, and as long as absolute reliance is placed upon the human element in the operation of trains, accidents are bound to occur, but until it can be shown that all reasonable and proper measures have been taken for its prevention no accident can be classed as unavoidable.
>
> All of the mistakes noted above are violations of simple rules, which should have been easily understood by men of sufficient intelligence to be entrusted with the operation of trains. The evidence is that in the main the rules are understood, but they are habitually violated by employees who are charged with responsibility for the safe movement of trains. The evidence also is that in many cases operating officers are cognizant of this habitual disregard of rules and no proper steps are taken to correct the evil. Many operating officers seem to proceed upon the theory that their responsibility ends with the promulgation of rules, apparently overlooking the fact that no matter how inherently good a rule may be, it is of no force unless it is obeyed. On very many railroads there is little or no system of inspection or supervision of the work of train-service employees so far as pertains to those matters which vitally affect safety. Employees are not examined on the operating rules except at the time of their promotion, and only

the most perfunctory efforts are made to determine their fitness to perform the duties assigned to them from time to time.

Seven of the collisions investigated during the year were caused by the failure of enginemen to obey the indications of block signals. One serious derailment also was due to this cause. In these eight accidents 78 persons were killed and 205 were injured. Disobedience of signal indications on block-signaled railroads is one of the most serious phases of the accident situation. Such disobedience often occurs in connection with the movement of important high-speed passenger trains, and when it results in a collision or derailment a most deplorable casualty list is its invariable accompaniment. Fourteen of the investigated accidents which have occurred on block-signaled roads since July 1, 1911, were caused by enginemen running by stop signals or failing to reduce speed as directed by caution signals. In these 14 accidents 105 persons were killed and 311 were injured. In seven of these accidents the culpable enginemen themselves were killed.

No adequate reason can be offered for these serious lapses from duty by men who in many cases suffer death as a consequence. Frequently it is hard even to suggest a plausible explanation for the disobedience of signal indications. That they are disobeyed, however, is a fact, and the lives that are annually sacrificed from this cause call loudly for some means of arresting its results. The most disastrous accidents of this character occur on roads equipped with modern systems of automatic block signals, where elaborate precautions to prevent accidents (short of guarding against the consequences of signal disobedience) have been taken. The trains involved in these lamentable disasters generally are operated by trusted employees of long experience. But the record abundantly proves that even splendid signal equipment and admirable discipline, coupled with long experience and high moral character on the part of employees, cannot prevent the occasional man failures which produce such fatal results. These facts are brought to the attention of the Congress, with the suggestion that these man failures indicate the necessity for the development and perfection of some system of automatic train control to be used in connection with existing signal systems. In its annua- reports for several years past the Commission has called attention to the desiral bility of legislation requiring the use of the block-signal system.

High speed was an important contributing cause of several serious accidents during the past year. On many roads there is no limit to the speed at which passenger trains are allowed to run. Enginemen are thus encouraged to run their trains at excessive speed in an effort to make up time lost on schedules that are in many cases already sufficiently fast for safety. Such high speed is especially dangerous in times of fog or storm, when signals can be seen but a comparatively short distance. The maximum allowable speed of trains on all roads should be established at a safe limit, and it should not be left entirely to the judgment of enginemen to determine whether or not this limit is exceeded. There are devices readily available which will indicate to an engineman the speed at which his train is running.

In its last annual report the Commission noted that the railroads were making progress in the substitution of steel and steel underframe passenger cars for those of wooden construction. The superiority of these modern cars over the old-style wooden cars has been amply demonstrated by their performance in both collisions and derailments, and to insure that all carriers make proper efforts to procure these modern cars, legislation should be enacted prohibiting the use of wooden cars in high-speed through train service after a certain date. Reasonable time should be given the carriers for compliance with the provisions of any law of this kind, and its application in the first instance should be confined to important high-speed trains. There are a great number of wooden cars now in service, and the carriers should be permitted to make use of these cars on branch lines and in local service until they can be replaced by steel equipment, but the law should provide that all new cars constructed after a certain date should be made entirely of steel or of steel underframe construction of approved design.

It is to be noted, however, that the Commission's remarks in its 1914 annual report were by no means of so scathing a character.

An analysis of the causes of the more prominent train accidents which occurred in the period from July 1, 1901, to March 31, 1914, has produced the accompanying table:

ANALYSIS OF CAUSES OF PROMINENT RAILROAD ACCIDENTS FROM JULY 1, 1901, TO MARCH 31, 1914

Compiled from I. C. C. Quarterly Accident Bulletins

Cause of accident	No. of accidents
Butting collisions due to neglect of orders by train crew .	332
Butting collisions due to neglect of orders by manual block-signal operators and telegraph operators.......	198
Rear collisions due to improper flagging (no block signal system)...	117
Disregard of fixed signals at danger....................	101
Open switch..	72
Collisions due to excessive speed......................	69
Derailments—due to excessive speed..................	63
Derailments—due to broken rail......................	58
Butting collisions due to error of despatcher............	44
Rear collisions due to disregard of flagman (no block signal system)..	20
Unknown causes (estimated).........................	19
Engineer dead or sleeping............................	18
Disregard of caution signal under permissive movement.	14
Side-swiping accidents, cars not in clear at sidings.......	6
Miscellaneous..	170
Defective rolling stock................................	78
Derailments—due to bad track........................	61
Unknown causes (estimated).........................	56
Failure of air brakes.................................	48
False clear signals....................................	9
Total..	1,553

It is now our duty to see what efforts are being made by railway men and others to reduce the number of train accidents on the railroads of this country. The treatment of this subject will include the following points: The adequate maintenance of roadbed and equipment; the safety-first movement; reduced speed and speed indicators; automatic signaling;

discipline and surprise tests; cab-signals and automatic stops, and the all-steel car.

Summary of Casualties on British Railways for 1913 and 1912, with Totals for Eleven Years

Class	1912		1913	
	Killed	Injured	Killed	Injured
A. Passengers:				
From accidents to trains, rolling stock, permanent ways, etc.	20	683	33	723
By accidents from other causes	100	2,843	117	2,918
Total of passengers	120	3,526	150	3,641
B. Servants of companies or contractors:*				
From accidents to trains, rolling stock, permanent way, etc	6	154	8	145
By accidents from other causes	397	28,046	455	29,102
Total of servants	403	28,200	463	29,247
C. Other persons:				
From accidents to trains, etc	....	4	....	3
Persons passing over railways at level crossings	69	32	64	46
Trespassers (including suicides)	458	127	458	132
Persons on business at stations, etc., and other persons not coming in above classifications	68	731	59	727
Total of other persons	595	894	581	908
Total all classes 1913	1,194	33,796	....	....
Total all classes 1912	1,118	32,620	1,194	33,796
Total all classes 1911	1,159	32,258	....	....
Total all classes 1910	1,121	30,110	....	....
Total all classes 1909	1,033	28,383	....	....
Total all classes 1908	1,128	28,485	....	....
Total all classes 1907	1,211	25,975	....	....
Total all classes 1906	1,252	20,444	....	....
Total all classes 1905	1,180	18,236	....	....
Total all classes 1904	1,158	18,802	....	....
Total all classes 1903	1,262	18,557	....	....
Total all classes 1902	1,171	17,814	....	....
Total eleven years	12,793	271,684	....	....

* Of contractors' servants in 1912 seven were killed and 29 injured.

The American railways have been striking at the heart of the accident problem with splendid effect during the past few years. As can be seen from the table on page 346 most accidents are to be ascribed to faulty maintenance of roadbed or equipment, to failures on the part of employees or to other causes beyond the control of the operating officers. That is to say, that if roadway and equipment are of high standard and properly maintained, an adequate signal system has been installed and there is strict—though reasonable—discipline, the larger part of the chance for accident has been removed. The problem is a great one, and like all others in the railway field needs the closest coöperation between departments and between the management and the men, as well as liberal expenditure.

The safety-first movement is not so much a new development as it is a mere elaboration of the time-honored principle of the old operating rule: "In case of doubt, take the safe course and run no risks," now succeeded by the more polished Rule 106, "In all cases of doubt or uncertainty the safe course must be taken and no risks run."

Safety first in its original form was directed almost entirely toward the employee, and its first efforts were confined to emphasizing to the men that they could best serve their railroad, themselves and their families by avoiding unnecessary risks. More recently, as the movement has widened in scope, an effort has also been made to include the railway patrons. In this, almost the entire stress has been placed on the mere idea of safety first and but few railways have gone further than to use such opportunities as have been at hand to caution the passenger to be careful. They have not embarked, as have the street railways, in campaigns of education with the idea of showing the patron tangible examples of what does not constitute safety first. Of course, the fields are different; the street railways have a tremendous lever in the car card advertisements.

The one great difficulty in the case of safety-first campaigns has been to keep the men interested. There have been safety-first meetings, safety-first contests, illustrated safety-first lectures and even safety-first motion pictures. The New York Central, for example, has safety-first cars. Some are fixed up with exhibits and pictures, while others used in connection with them are provided with seats and a screen. On the screen before the audience of employees, there are shown stereopticon views and motion-picture plays, this road having taken a new step in this matter in its preparation of "Steve Hill's Awakening," a two-reel film posed as a railroad safety-first picture by professional moving-picture actors.[1]

On one road the instructions regarding safe train operation are likewise given in a car specially fitted for that purpose. This car is moved over the line twice a year and stops at all important points. About one-half the car is used to seat the class; the remaining portion for the heating plant, dark room and other facilities for developing and making lantern slides of pictures taken along the line. The equipment includes a combined gas-electric stereopticon machine and an oxyhydrogen (OH) gas generator for use at points where electric current is not obtainable. There are also gas and electric lighting facilities. The lectures usually last two hours and are illustrated by stereopticon views of the division over which the car is being moved. All signal and interlocking devices, in their different positions or aspects, special track work and other things and conditions not likely to be understood by the average employee are shown in detail and explained. The car and the instruction work are in charge of an expert from the signal department.

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[1] Marcus A. Dow, General Safety Agent of the New York Central, has also produced a second film entitled, "The House That Jack Built."

Summary of Railway Accidents in Germany for the Years 1911 and 1912

	1911		1912	
	Killed	Injured	Killed	Injured
Passengers:				
In accidents to trains	2	422	6	348
Other accidents:				
Without fault of their own	4	72	1	57
As result of their own carelessness	91	178	124	226
Total passengers	97	672	131	631
Employees on duty:				
In train accidents	14	202	24	181
In other accidents:				
Through their own carelessness in trains or cars in motion	62	297	82	277
In making up trains	60	239	75	272
In coupling cars	92	175	120	217
While on tracks in way of moving cars or trains	240	218	295	280
Through other forms of carelessness	75	219	86	230
Total employees on duty	543	1,350	682	1,457
Post, telegraph, police, and customs staff	6	68	15	69
Trespassers, including employees not on duty	280	248	326	311
Suicides	338	27	457	31
Total trespassers, etc	624	345	798	411
Total all classes	1,264	2,365	1,611	2,499

Contemporaneously with the safety-first movement there has arisen a tendency to limit the speed of fast passenger trains and not only to eliminate the possibilities of excessive speed but also to lengthen the schedules. The general tendency on the part of the more conservative railway managers and the more sensible and thinking part of the traveling public is to drift away from the American speed craze and to lean toward safety, punctuality and regularity of movement. Stress is being put less and less on the necessity for making up time and more and more on the necessity for the absolute safety of passengers and trains. Nearly all the public-service commissions, including the Interstate Commerce Commission, have expressed themselves, more or less emphatically, in favor of a regularly maintained train service at reasonable speed as against spectacular high-speed performances with their accompanying uncertainties. That this better policy carries with it, in addition to increased safety, greater economy in operation is well known.

Average Number of Passengers Killed and Injured in Train Accidents on British Railways, 1875 to 1912[1]

Year	Number of passengers killed and injured in train accidents		Number of passenger journeys (exclusive of journeys by season-ticket holders) * (millions)
	Killed	Injured	
1875–1884 (Average)	28	915	598.4
1885–1894 (Average)	21	600	798.6
1895–1904 (Average)	12	581	1,100.7
1905–1909 (Average)	23	447	1,248.4
1910	23	1,111	1,306.7
1911	14	324	1,326.3
1912	20	683	1,294.3

* The number of annual season tickets issued was 779,173 in 1911 and 785,135 in 1912.

The comfort of passengers and the proper care of equipment both demand that the operating officer do his utmost to have his trains handled as smoothly as possible. It is essential that speed be properly and uniformly maintained and that there be a minimum of shock at starting and stopping. Many methods are followed to prevent trains from exceeding the speed permitted at points where restrictions are necessary. Usually the maximum velocity in miles per hour is mentioned in the time-table and as a local reminder to the engineman a "slow-board" is placed at a predetermined distance in advance of the point where the speed restriction is to take effect. Where an absolutely close and rigid compliance is essential, as at a drawbridge, time records may be installed by means of which the speed of any train may be ascertained at any time by reference to the charts which record the time elapsing while the train (or engine) passes from one fixed point to another.

Speed indicators and recorders designed for attachment to locomotives are very often desirable because they give to the engineman readily the information which many of them, strange to say, cannot estimate—the speed of the train. There are many types of indicators. One good machine that is widely used is the indicator and recorder manufactured by the Hasler Telegraph Works (London) which costs about $125—attached to the locomotive and ready for service.

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[1] Railway Library, 1913.

In the report of the Committee on Rails and Equipment, presented before the meeting of the National Association of Railway Commissioners, held at Washington, D. C., Oct. 28–31, 1913, occurs the following: "The need is also indicated of a reliable speed indicator and recorder for use on fast passenger locomotives to show engineers the speeds which they are making and to enable superintendents and train masters to check excessive speeds and secure the maintenance of a reasonably uniform average. Some effort has been made in this country to secure and use such an apparatus. The most important effort in this line, we believe, was made by the 'Soo' line, speed recorders having been used for several years on all important passenger and freight locomotives. Experiments along this line are being made by the Erie Railroad". . . . An important use of recorders is being made by the Delaware & Hudson on 20 Mallet locomotives. These locomotives are among the heaviest in the world and are designed especially for slow pushing service on mountain grades. It was thought necessary for good operation and economical maintenance to restrict the speed of these locomotives to 15 miles an hour, and to secure positive evidence that such instructions are being carried out, the "Flaman Speed Indicator" has been applied. This is a German invention which makes a chart of the entire trip and gives a diagram of the speed, the location on the line, and a record of any abuse to which the engine may have been subjected on account of the drivers slipping. These charts enable operating officers to determine whether the speed limit is exceeded in any portion of the run. They can absolutely judge from the record of the locality in which the excess speed occurred whether any extenuating circumstances exist. These charts are removed every 24 hours and a study of them is made by an employee who calls the attention of the master mechanic or superintendent to any irregularities indicated. It is stated that it is rarely necessary to call the engineman's attention to irregularities shown by the device as in most cases he fully recognizes that it tells the story accurately and that discipline will be administered in accordance therewith. The annual maintenance cost of the apparatus is thought to be about $50.

George Westinghouse once made the statement:

> "The conclusion that one familiar with the problems involved inevitably reaches is that the first and greatest step to be made in the direction of safety is the limitation of the maximum allowable speed of trains, and to this end locomotives must be fitted with speed-indicating and recording apparatus to show engineers the speed of the trains and furnish operating officials a graphic record of such speeds. Such a device is available and can be combined with an effective automatic apparatus to apply brakes when the maximum allowable speed is exceeded. Such speed limitation would enable signal engineers to arrange their

signaling apparatus to be much more protection than when there is no speed limitation, and thus also a safer speed would greatly reduce the destructive action of heavier trains upon the permanent way."

Killed in European Railway Accidents[1]
(Miles of Line Represented, 194,682)

Country	Year	Passengers	Employees	Other persons	Total	Preceding year
United Kingdom	1912	120	403	595	1,118	1,159
Germany	1911	115	563	706	1,384	1,264
Russia (*a*)	1909	206	620	1,860	2,686	2,950
France	1910	(*b*)71	320	(*c*)362	753	692
Austria	1911	16	134	131	281	294
Hungary	1911	54	153	187	394	353
Italy	1910–11	24	101	222	347	355
Spain	1909	11	65	242	318	303
Portugal	1904	....	....	....	55	37
Sweden	1909	5	32	59	96	91
Norway	1911–12	2	3	9	14	16
Denmark (*d*)	1911–12	2	11	18	31	26
Belgium	1911	14	85	65	164	168
Holland	1911	3	11	23	37	61
Switzerland	1911	12	31	56	99	85
Roumania	1911–12	14	54	83	151	104
Total Europe	1912	669	2,586	4,618	7,928	7,958
Europe (*e*)	1911	554	2,607	4,465	7,626	....
Europe (*e*)	1910	692	2,689	4,461	7,897	....
Europe (*e*)	1909	671	2,641	4,322	7,689	....
Europe (*e*)	1908	630	2,536	3,580	6,803	....
Europe (*e*)	1907	586	2,575	3,400	6,606	....
Europe (*e*)	1906	560	2,319	3,553	6,432	....
Europe (*e*)	1905	503	2,104	3,414	6,021	....
Europe (*e*)	1904	412	1,920	2,665	4,995	....

(a) Exclusive of local lines and railways of Finland.

(*b*) In train accidents only.

(*c*) Excluding suicides, but including passengers killed otherwise than in train accidents.

(*d*) State railways only.

(*e*) These figures are those compiled for the Bureau of Railway News and Statistics each year since its organization, the details for each country appearing in the report for the following year.

The science of railway signaling has advanced with great strides in the last 20 years. The modern automatic signal can truly be said to be a marvel of efficiency. Its average movements per false clear indication are 2,000,000, a figure which can scarcely be improved upon. The study which has been given the subject of signaling is entirely merited, for there are few factors in safe operation more important. With adequate signal facilities, although the danger of collision is not absolutely eliminated, it is reduced to the minimum. For that reason, the Interstate Commerce Commission has appealed to Congress to require the installation of block signals by law.

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[1] Railway Library, 1913.

The Commission has also emphasized the fact, however, that the best of signals will be of no value if they are not observed. The way to compel their observance is by means of proper discipline and supervision. With the best facilities possible there will still be accidents if every man who is engaged in operating a train does not feel his responsibility and his accountability. For safe operation there must be ample forces, but there is no room for superfluous men. Superfluous men are an unnecessary evil. The effect on discipline of a force of idlers with its resulting deterioration of service to the public is obvious. All the mechanical safeguards that have been, or ever will be, invented, can never eliminate that responsibility which rests upon the individual. Every man should have a duty to perform and upon his fidelity and his intelligent discharge of that duty will depend the successful handling of the mighty transportation machine. When non-essential men are kept in service, or—through legislation, regulation or mediation—forced into service, and, in natural consequence, essential men needed for the proper conduct of business elsewhere are laid off, inferior service results; the element of safety is jeopardized, and the public becomes dissatisfied.

The obligation of responsibility extends to the officers even more than to the men. The great majority of the men in train and engine crews do feel their responsibility most keenly, but they cannot be expected to act in the most efficient way if the officers to whom they report do not show the fullest interest themselves. Road foremen and train masters cannot spend too much time on the road where they can see what is going on for themselves. The service they can render in the intelligent instruction of the men cannot be estimated. It is intelligent criticism, not nagging, that makes the men more efficient.[1]

The safety of trains and passengers demands the absolute observance of signals. The most important means of compelling such absolute compliance with signal indications is thorough discipline. The operating officer has few ways of assuring himself that signals are properly obeyed. Efficiency tests are his best safeguard. They have the twofold purpose of serving as tests and thereby giving him a line on his men, and of serving as a preventive. If an engineman realizes that in passing a stop indication he may be so doing under the eyes of a superior having the power of discharge, he is likely to take the safe course and stop. Many roads have used the efficiency tests with remarkable results, the number of failures to observe the rules in a given number of tests usually being remarkably small.[1]

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[1] See also Chap. VIII of Freight Terminals and Trains on "Management and Discipline."

Even efficiency tests, however, cannot prevent all accidents that may result from non-observance of signals. There have been cases where enginemen have seen stop signals and have not stopped (with dire results to their trains and themselves) either because they were dazed, because they did not transmit the indication they saw with their eyes to their brains or for some similar cause.

To counteract such dangers automatic stops and cab signals have been proposed. Both of these devices have received considerable attention. It has even been claimed by some who speak beyond their funds of information that the automatic stop will prove the panacea for all accidents. So well grounded has that fantastic idea become that almost every inventor who deserves the name, and literally multitudes of others who claim it, have tried their best to bring out the real automatic stop.

The cab signal is a miniature signal in the cab which gives to the engineman the indication of the signal which he is approaching. Its peculiar usefulness is where there is much snow or fog, or where an engineer's view of the semaphore would be obstructed by reason of sharp curves. Cab signals have been tried on a number of roads in England, among them the Great Western, and have been recommended by the Board of Trade. The German authorities have made experimental installations. The French State railways have even gone so far as to plan to install them on all lines. There have been but very few installations of cab signals in the United States. Improvements in signaling in this country have taken other courses, and much more stress has been placed on the daylight signal, which overcomes many of the difficulties due to fog, or on the better arrangement of signals. The cab signal is usually held to be more practical than the automatic stop and by reason of its assisting the engineer rather than checking him it is more to be commended.

The average American railroad officer at the present time is much opposed to the automatic stop, principally on the ground that it is not practical, although, that is not the only reason. The automatic stop inventors have, nevertheless, received considerable encouragement. The New Haven has offered a prize of $10,000 for a practical device; it is significant that although 3,300 plans have been submitted by inventors, not one has proved itself of sufficient value. The Interstate Commerce Commission has also done a large amount of work along the same lines. Other railroads than the New Haven have also been interested, and on April 1, 1914, experiments with automatic train control devices were being conducted on 12 railways with 14 different devices.

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[1] In the first six months of 1915 the Pennsylvania Railroad made about 2,000,000 efficiency tests, and 99.9 per cent. of them showed perfect observance of all rules. Over 10,000 tests were made with signals set at stop, and in only 13 cases did the trains fail to stop before passing the signal by so much as a foot. The number of employees killed in the first six months of 1915 was 28½ per cent. less than in the corresponding period of last year—85 this year, 119 last year. This, it is said, was not due to a heavy decrease in train mileage, as passenger train miles were only 6 per cent., and freight train miles 8 per cent. less than in 1914. No passenger has been killed in a train accident on the Pennsylvania since 1912.

Average Fatalities per Million Passengers During Latest Five Years to which Statistics Extend[1]

	Per million passengers			Per million passengers	
	Fatalities	Persons injured		Fatalities	Persons injured
Austria	0.08	1.92	Russia in Europe	1.47	....
Belgium	0.09	3.0	Russia in Asia	4.19	....
Germany	0.08	0.44	Sweden	0.08	0.25
Hungary	0.26	1.24	Switzerland	0.12	0.93
Netherlands	0.07	0.48	United Kingdom	0.08	2.15
Norway	....	0.16	United States	0.51	....
New South Wales	0.10	2.36	Victoria	0.09	3.37
South Australia	0.11	3.68			

The American Railway Association has formulated the following requisites for automatic train control:

An installation so arranged that its operation will automatically result in either one or the other or both of the following conditions:

First.—The application of the brakes until the train has been brought to a stop.

Second.—The application of the brakes when the speed of the train exceeds a prescribed rate and continued until the speed has been reduced to a predetermined rate.

REQUISITES OF INSTALLATION

Note.—These requisites are drawn for application in connection with a properly installed block signal or interlocking system.

1. The apparatus so constructed that the failure of any essential part will cause the application of the brakes.
2. The apparatus so constructed that it will automatically control the train in the event of failure by engineman to observe signals or speed regulations.
3. The apparatus so constructed that it will control the train in the event of a failure of fixed signals to give proper indications.
4. The apparatus so constructed that proper operative relation between those parts along the roadway and those on the train will be assured under all conditions of speed, weather, wear, oscillation and shock.
5. The train apparatus so constructed as to prevent the release of the brakes after automatic application has been made until the train has been brought to a stop or the speed of the train has been reduced to a predetermined rate.

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[1] From a note in *Engineering*, London.

6. The train apparatus so constructed that when operated it will make an application of the brakes sufficient to stop or control the train within a predetermined distance.

7. The apparatus so constructed as not to interfere with the application of the brakes by the engineman's brake valve or the efficiency of the air-brake system.

8. The apparatus so constructed as to be operative when the engine is running forward or backward.

9. The apparatus so constructed that when two or more engines are coupled together or a pusher is being used the apparatus can be made effective on the engine only from which the brakes are controlled.

10. The apparatus so constructed as to be operative on trains moving only with the current of traffic.

11. The apparatus so constructed as to conform to The American Railway Association standard of clearances of rolling equipment and structures.

12. The apparatus so constructed as not to constitute a source of danger to employees or passengers, either in its installation or operation.

13. The apparatus so constructed as not to interfere with the means used for operating fixed signals.

ADJUNCTS

The following may be used:

(*A*) Cab signal; a signal located in the engine cab indicating a condition affecting the movement of the train and so constructed that the failure of any part directly controlling the signal will cause it to give the "stop" indication.

(*B*) Detonating signal apparatus; an apparatus located along the roadway and so constructed as to give an audible signal by means of a torpedo or other explosive cartridge.

(*C*) Speed indicator.

(*D*) Recording device; an apparatus located on the train and so constructed as to make a record of the operations of the automatic applications of the brakes and of the speeds of the train, and such other records as may be desirable.

Automatic stop devices have been giving highly successful service on a number of electric rapid transit lines for many years. The original installation on the Boston Elevated, a combined elevated and subway line, dates from about 1899. In this installation there is directly connected with each semaphore and operated by it by means of a pipe connection, a trip which when the signal indicates stop is held in an upright position beside the rail. Should a train attempt to pass the signal this trip will hit a little rod hanging from the front end of the first car, which rod on being pushed back will work to shut off the current and apply the brakes, causing the train to stop in a very short distance. In the Washington Street tunnel connected with this line, there are, of course, no semaphores; the trips are operated independently of the light signals. On this combined elevated and subway line, there are no caution signals and no overlaps. In later installations which this company has made, as in the case of the Cambridge tunnel, caution signals are used.

The Interborough Rapid Transit in New York has used automatic stops on its subway lines for a number of years. The first installation was made on the express tracks between Brooklyn Bridge and 96th Street, said to be the busiest tracks in the world, about five years after the first installation in Boston. The automatic stop has since been extended to other sections of the subway lines. The Interborough uses an overlap and the signaling is so devised that any two trains must be at least a full block apart. That means that if a train going full speed passes a stop signal it will stop before it can possibly run to the signal immediately to the rear of the train in advance.

The Hudson & Manhattan lines, using the tubes under the North River between New York and Jersey City, use an automatic stop, the distinguishing feature of which is the use of a rigid bar placed in front of the lever on the forward car for the purpose of clearing obstructions from the track. If the train tries to pass a signal at danger the rigid bar strikes the trip by the side of the rail and turns it to a horizontal position so that another part of the mechanism is brought into position to strike the movable bar which works the apparatus on the train.

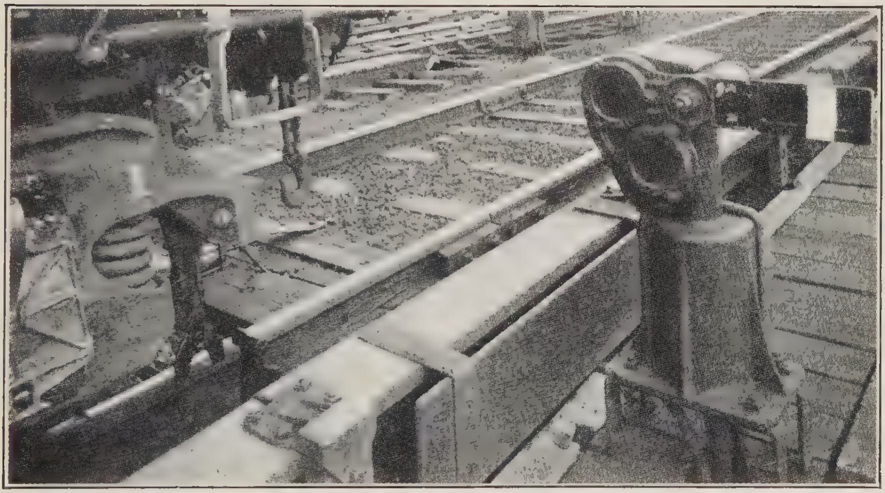

Fig. 207.—Automatic stop on the Interborough Rapid transit.

Although these and various other installations of like character on electric railways have been highly successful, there have been but very few installations on steam roads. One of those which has received considerable attention is that now in use on the Chicago & Eastern Illinois. The device, known as the Miller automatic train stop apparatus, has been applied on over 90 locomotives and is controlling trains over 107 miles of double track on the Chicago division. Part of the installation at this writing (1915) has been in use two years. At a distance to the rear of each signal so adjusted that a train moving 60 miles an hour would be stopped at or to the rear of the signal, there is a ramp of 35-lb. standard T-iron, 108 ft. long, fixed on the ties 22 in. outside the track rail. This ramp has a short insulated section in the middle so that it is really two separate contact pieces. It is meant to engage a contact member on the engine in the form of a shoe fastened to the bottom of a vertically moving piston held by a strong spring, this part of the apparatus being supported on the crosshead guides. The piston is raised 3 in. when it strikes the ramp and this movement opens a valve allowing air pressure from the brake line to enter a small air cylinder in the cab. This pressure in turn forces another piston upward, and this operates a crank controlled by an electric lock. The latter revolves if its magnet is de-energized but not if the magnet is energized. If it revolves, an arm attached to it operates a three-ported valve, allowing air pressure from the train line to enter the operating cylinder. This operation opens the engineman's air-brake valve, giving a service application, and closes the throttle. The electric lock is operated by a current from the road-side battery conveyed by a wire from the shoe through a pipe to the box in the cab which contains the lock. The ramp when not electrified will cause an application of the brakes but if it is electrified it will energize the magnet and prevent the operation of the apparatus. There are no visual or audible signals other than the regular block signals. There are likewise no speed recorders. As at present arranged the apparatus is not affected by the speed of the train. Plans have been made to cover this feature but not yet applied. The operation of the installation has been very closely watched and its work has given great satisfaction. Various experiments have been made with the idea of improvement. For one thing it was found that the method of first applying the air and then closing the throttle, although it worked all right with fast passenger trains was not satisfactory in the case of freight trains. Now, on freight engines, the air is applied by the apparatus but the throttle is in complete control of the engineman.

There are few other automatic train control devices designed for use on steam railways that have attained even as great success as this one. There are various others that have received favorable consideration, but lack of space will not permit of their description here.

In view of the fact that the automatic stop as applied to steam roads has not yet gone beyond the experimental stage, it is not hard to see that those who term the automatic stop the panacea for all accidents at this stage of the development do not know of what they speak. That but a portion of all the important accidents result from conditions that might have been forestalled by automatic train control is but a secondary matter to such as make these statements.

The Joint Committee on Automatic Train Stops of the American

Railway Association went so far as to say in its report rendered in May, 1914, that

> Not one of the devices for the automatic control of trains which have been tested on a number of roads meets the committee's requirements. No automatic train control apparatus, so far as known, can be universally applied without adding elements of danger in train operation. The expediency of its installation at any particular point must be determined by all the surrounding conditions. The requisites of installation for a train control system, as formulated, are designed for application only where the conditions of traffic are such as to justify the use of an automatic block-signal or interlocking system; but the operation of the automatic block-signal or interlocking system, if properly installed and maintained, is so near perfect as to indicate that the efforts of operating officials and public authorities should be directed toward the enforcement of obedience to signals rather than in the installation of additional devices.
>
> Great care must be exercised in working out a system of automatic train control, in order to avoid the introduction of new elements of danger in operation which may offset those they are intended to overcome. The successful stoppage or reduction in the speed of a train composed of many freight cars or of heavy passenger equipment requires the exercise of skill and judgment on the part of the engineman in handling the air brakes. If this is improperly done, serious damage to the train and possibly to the track and to trains on parallel tracks may follow. The sudden application of the brakes by an automatic device without the exercise of intelligence in its performance is, therefore, necessarily hazardous.

Railroad men, as a general thing, are radically opposed to the idea of automatic train control. Their objections are well founded and many. A large number of the detriments they allege relate to the necessity of running fast passenger and long freight trains over the same controlled territory. They declare that because of the overlap required for stopping space for fast trains, the present track capacity will be considerably reduced, whereby the freight service, in particular, will suffer unless enormous sums are spent for increased trackage. No satisfactory proposition has yet been advanced to get around the stop and proceed requirements of present-day operation under the automatic block-signal system. On electric lines, a train held by a signal connected with an automatic stop cannot proceed until the block which that signal governs is clear; in other words, the present effective devices allow no proceed movements past a stop indication. To require the same method of operation on steam roads will eliminate the permissive stop with all its advantages, and of these there are not a few. But, if the stop device were such that a train could pass over it at a speed of 5 miles an hour or less, there would be no guarantee that a light train might not increase its speed again and plunge into a preceding train which for some reason may not have yet passed the next signal in advance; or in other words, the protection is not complete. On electric lines where automatic train control has proved a success, the trains governed in any one case are alike. The same device that would satisfactorily stop a passenger train might, on the other hand, cause a pile-up or a break-in-two in a freight train; that problem is yet to be solved. Nor is it certain that any device has yet been perfected that will work satisfactorily in all kinds of weather.

The first and only object of the automatic stop is to provide against the failure of enginemen to see and obey signals. The automatic block-signal system is remarkably efficient. To introduce an adjunct—the automatic stop is nothing more—that will not be equally infallible cannot be justified. The automatic stop at present is but an experiment as far as steam roads are concerned, and to maintain that it has now attained the requisite degree of efficiency is no less than absurd.

It used to be said that the automatic stops would influence enginemen to depend more on the stop than on their own eyesight and vigilance. It has been demonstrated, however, that stops stimulate vigilance rather than the opposite, and it is noteworthy that officers of the Boston Elevated report that disregard of stop signals has been done away with. It has also been alleged that recording apparatus might be necessary to show when stops were overrun. No recording apparatus is used either on the Boston Elevated or the Interborough. The improvement in discipline alone seems to have jusified the use of the stops on these roads.

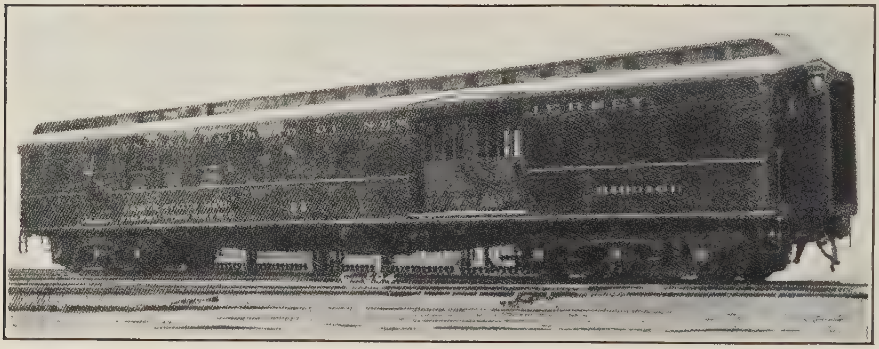

FIG. 208.—All-steel baggage and mail car.

Of all the arguments against the automatic stops, however, the strongest is the enormous cost of introducing them. It has been shown that most of the greater collisions of the past few years that would have been prevented by automatic stops could have been prevented by much simpler and cheaper means, such as stricter discipline or more adequate methods of signaling. It is alleged that money would be far better spent on such as these or on things that might go to prevent accidents such as result from derailments or inferior equipment. Of the soundness of that argument there can be no doubt.

In the final analysis, the automatic stop, as it stands at present at least, is not an adequate preventive of accidents. It eliminates but one class of accidents and has by no means been so perfected that it is sure to operate under the severe conditions imposed on any mechanism by the character of steam railroad service. No stop has yet been devised which meets the requirements of the American Railway Association. Even if such a stop could be devised, the question arises whether the enormous cost of installation and maintenance could not be spent to much better advantage elsewhere. No well-managed road begrudges money spent which will render safer the transportation of its passengers, but under present conditions the spending of money for the installation of automatic stops does not seem wise. It is far better that the money should be spent for the extension of the automatic block-signal system which has proved its worth and efficiency; in the instruction of employees; in the improvement of the roadway and track; and in the purchase of better and more modern equipment.

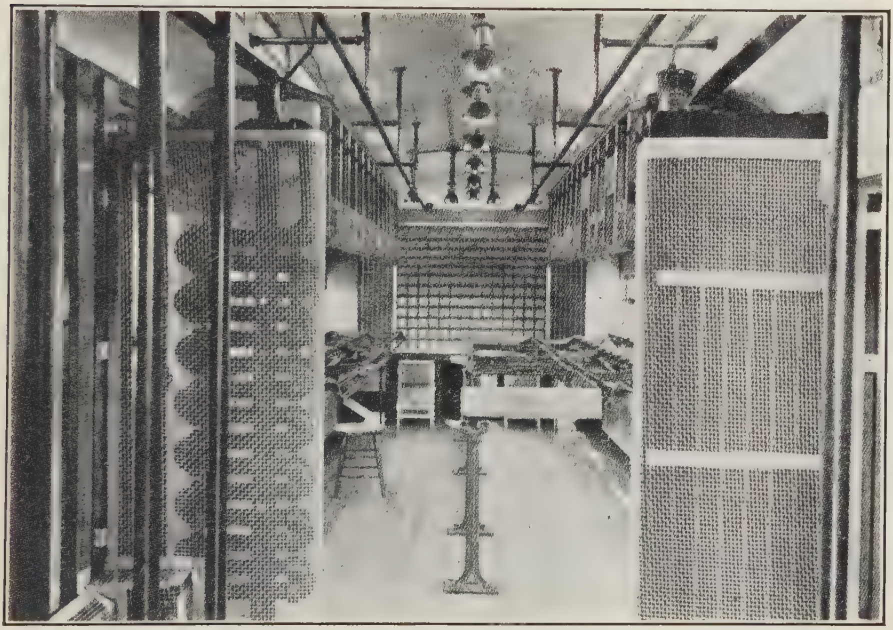

FIG. 209.—Interior of all-steel baggage and mail car shown in Fig. 208.

What the future may develop in this matter remains to be seen. There can be no doubt that there is a strong public opinion favoring the automatic stop. Still less can there be doubt that this feeling is encouraged at intervals by occasional accidents of considerable importance. There is always that possibility, in consequence, that public feeling, working through Congress, the state legislatures or the public service commissions may some day demand cab signals or automatic stops or both, and it is significant that the Interstate Commerce

Commission itself is already working to that end. Cost to the railways in cases like these, from the standpoint of the governing or regulating body, is a very secondary consideration, and if it can be shown that automatic stops can do some good, even if they do not eliminate all accidents, that may prove enough. It will be for the railroads to prove absolutely that the stops are not feasible or to produce the proper device, for otherwise they may be compelled to install a very inferior mechanism of but doubtful value. In other words it is their duty to forestall their critics by having the facts or the stop.

The all-steel car is not a preventive of accidents. Its great value arises because, as has been definitely shown, it minimizes the fatal results of accidents. It is for that reason that the steel car has attained a position of respect on the part of railway men that the automatic stop can only hope to attain. The railways of this country have definitely taken up an allegiance to all-steel equipment, and in most cases are replacing their old wooden passenger cars as fast as their finances permit. Some roads, such as the Pennsylvania, have not only announced their intention of retiring all their wooden passenger cars but also of buying in future nothing but steel underframe or even all-steel freight cars. A great many roads have already succeeded in installing an entire through service of all-steel passenger cars, and some, of which the Lackawanna is one, are well on their way toward eliminating the wooden car from even suburban service. How the matter stands at present may be seen by the fact that of 3,092 passenger cars ordered in 1915 by roads in the United States and Canada, 2,874 were all-steel and 94 had steel underframes. On December 31, 1914, there were in service in the United States 43,512 wooden passenger cars, 5,700 cars with steel underframes, and no less than 12,900 of all-steel construction. The number of all-steel cars in service in 1909 was only 629. Of the passenger cars built in 1909, 51.4 per cent. were of wood; of those built in 1914, 4.5 per cent. were of wood.

Steel cars are being introduced for the following reasons:

The burning of wooden cars in wrecks.

The splintering of large wooden sills, etc., of wooden cars, causing injury and death.

The scarcity of lumber.

In collision with steel freight cars, now quite common, wooden passenger equipment is more likely to suffer than steel.

Increased speeds, greater train lengths and larger capacity cars.

The use of steel cars has a great advertising value.

The steel car has long since proved its worth, and has come to stay. It must be borne in mind, however, that the proper way to prevent loss of life in accidents is to prevent accidents. The steel car can minimize the effect of an accident, but it cannot prevent collisions and derailments. Other remedies must be sought to accomplish that end.

CHAPTER XXI

THE COMMISSARY

Dining cars were first introduced on American railways as more or less of a necessary evil. They were intended primarily to enable fast competitive trains to maintain or quicken their schedules by eliminating the time formerly required for stops for meals. As a secondary consideration they had an advertising value and there was likewise a vague hope that ultimately they would pay, or nearly pay, their own way. It is doubtful, however, if the dining car service as a thing by itself has ever proved profitable. It may, in fact, be stated that as a general proposition it is hardly self sustaining—even omitting from consideration, charges to capital account for the purchase of the car itself[1] and charges for maintenance, depreciation and obsolescence. The last alone cuts no very small figure at this time when so many wooden dining cars that otherwise might have had many years of service ahead of them have had to be discarded that they might be replaced by the all-steel cars demanded by the needs of modern transportation.

FIG. 210.—Typical modern all-steel dining car.

Dining car service, despite the fact that it very rarely pays for itself, is an absolute necessity to the railroads and so important does it prove that lines have been known to secure business from their competitors purely on the basis of their dining service alone. It is noted of American passenger service that the supreme effort made is toward convenience and service, and that financial considerations are a secondary matter. American dining car service is an epitome of that in every way.

The dining car service on lines like the New York Central, the Pennsylvania and the New Haven is enormous and intensive. On these roads two dining cars are not infrequently operated on one train. The New

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[1] A modern steel dining car weighs about 160,000 lb. and costs from $18,000 to $22,000. The Pennsylvania now calls them "Restaurant Cars."

Haven's Merchant's Limited[1] until recently carried a dining car seating 48 persons; during December, 1914, an average of 138 meals were served each trip, with a maximum of 164. The magnitude of this undertaking may be appreciated when it is understood that westward—the heaviest service—this work is substantially all done between Providence and New Haven—a distance of 120 miles and during a time period of two hours and 25 minutes. To contrast this with the car running from Washington, D. C. to Key West on the West Indian or "Over-Sea" Limited of the Atlantic Coast Line and Florida East Coast—1,320 miles; 40 hours—on which perhaps 200 meals are served on an entire trip, will show within what wide limits the dining service on American railroads ranges.

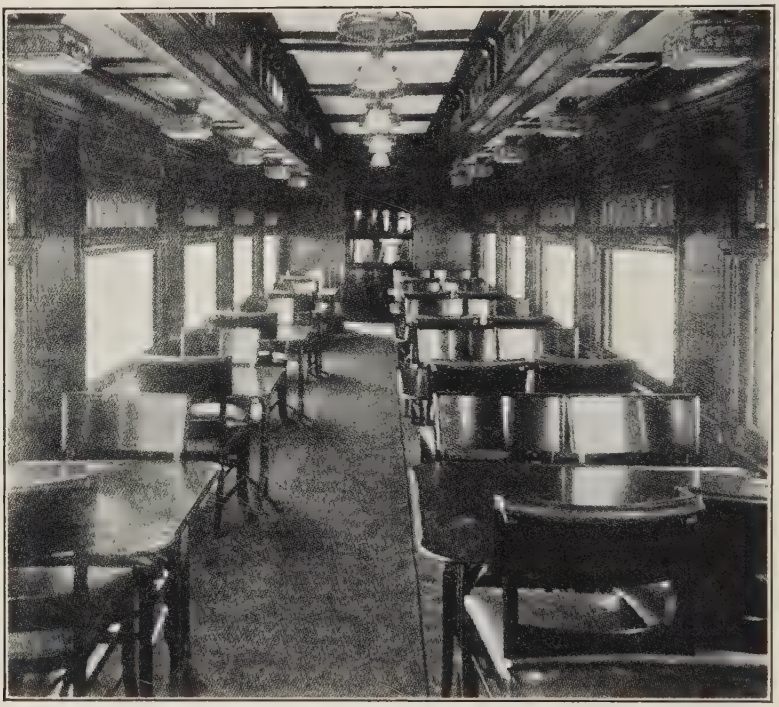

Fig. 211.—Interior of Southern Railway dining car.

Dining cars as usually arranged accommodate from 30 to 48 persons at a sitting. They sometimes contain six tables seating four each and a like number of tables seating two each. In other cases they contain 12 tables all seating four each, this arrangement necessitating a narrower aisle and more skillful work on the part of the waiters. The crew of a large and busy diner ordinarily consists of a steward,[1] a chef, a cook and two assistants; six waiters—one to each two tables or to each six or eight persons—and a water or table boy.

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[1] Five-hour train with limited seating capacity between New York and Boston leaving either terminal five o'clock P.M. This train now carries two dining cars one of which serves meals table d'hôte and the other à la carte.

During the month of October, 1914, the New Haven operated 12 dining cars—out of its total equipment of 20 cars—which were probably worth about $400,000. These 12 cars in actual service made 88,700 miles running 175 round trips. There were 33,440 revenue meals served and 7,285 free meals to dining car employees.

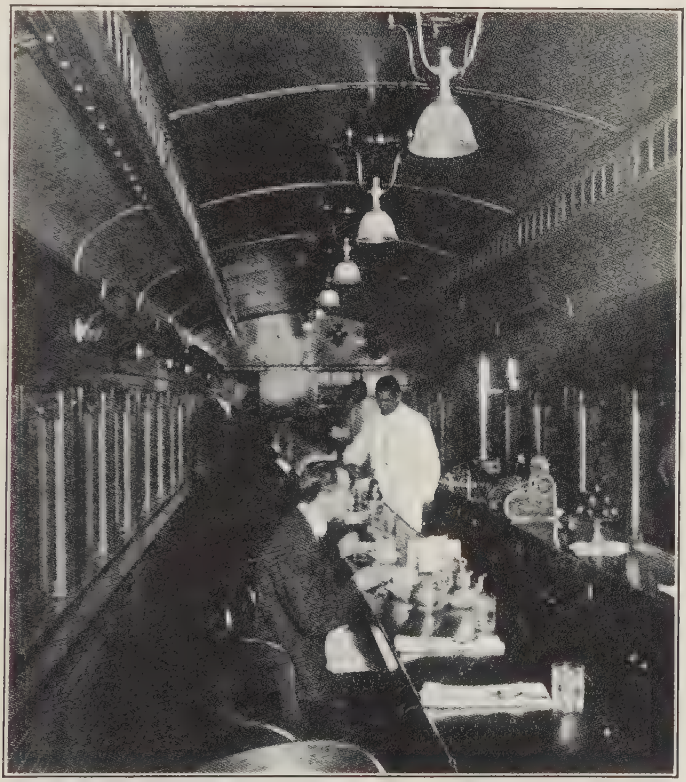

FIG. 212.—Pennsylvania Railroad lunch counter car.

The difficulties of the problem and the necessity for conservation of both kitchen and table space are brought home when it is recalled that a western road is experimenting—and successfully—with oblong and square plates and platters.

Two or more of the roads in the middle west, of which the Wheeling & Lake Erie is one, are employing women instead of men as waiters in the hope—successfully realized in the more established cases—of improving the hygienic and sanitary conditions, and of economizing.

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[1] On some roads an assistant steward is provided if the expense is warranted.

It will not be amiss to review briefly the manner in which the difficult problem was met on the Pennsylvania through the expedient of a lunch counter car. On many heavy express trains the dining car is unable to serve all passengers properly and much annoyance is caused by compelling persons to stand in a narrow passageway while the more fortunate preceding diners finish their meals in a leisurely manner. The lunch counter car is run on trains which also have regular dining cars. It is 80 ft. long and instead of tables contains a long mahogany counter extending over half the length of the car, with revolving stools on one side seating 21 persons at a time. On the service side of the counter against the wall are cupboards for supplies, receptacles for crushed ice, drinking water, ice cream, milk and cream, and under the counters are shelves for linen and silver. Sunk in the end of the counter farthest from the kitchen is a cigar humidor. At one end of the car is a wash basin for the use of passengers. The pantry and kitchen are at one end of the counter; the pantry has dish racks, a cupboard, a sink and a locker. Between the kitchen and pantry are openings with sliding doors, through which food may be passed. The openings are just above the serving

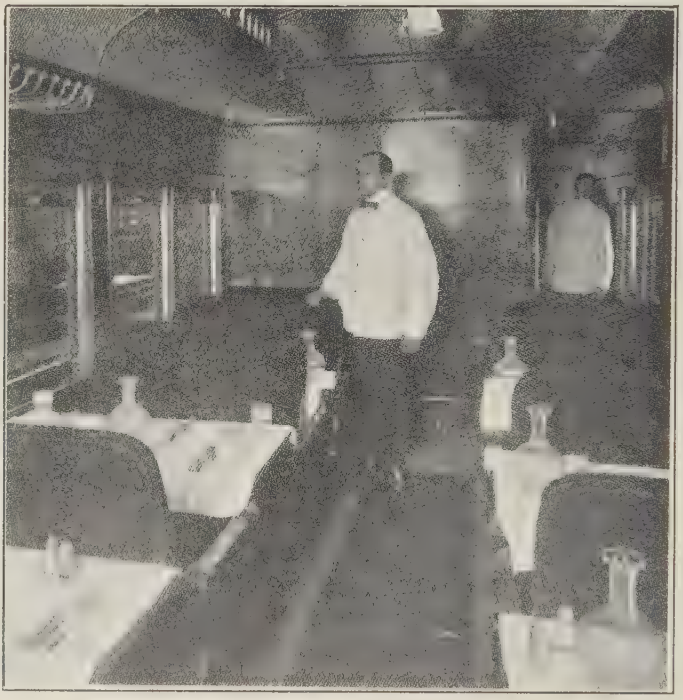

Fig. 213 —Pennsylvania Railroad café coach.

table in the pantry; consequently, waiters need not go into the kitchen. The latter is about 11 ft. long and contains broilers, a range, steam table, ice box, coffee urn, soup receptacle and meat warmer.

The Pennsylvania has also put in experimental service a café day coach. This is provided with a broiler buffet from which meals are served. The car is used on trains not requiring a dining car. The buffet is similar to that of Pullman cars; but is provided with alcohol broilers. It occupies about 8 ft. of space at one end of the car. Meals are served on tables placed between the seats, with the outer ends resting on the arms. Both single and double tables are provided. The car has a seating capacity of 70 and with the exception of the buffet, it is exactly like the standard Pennsylvania steel day coach.

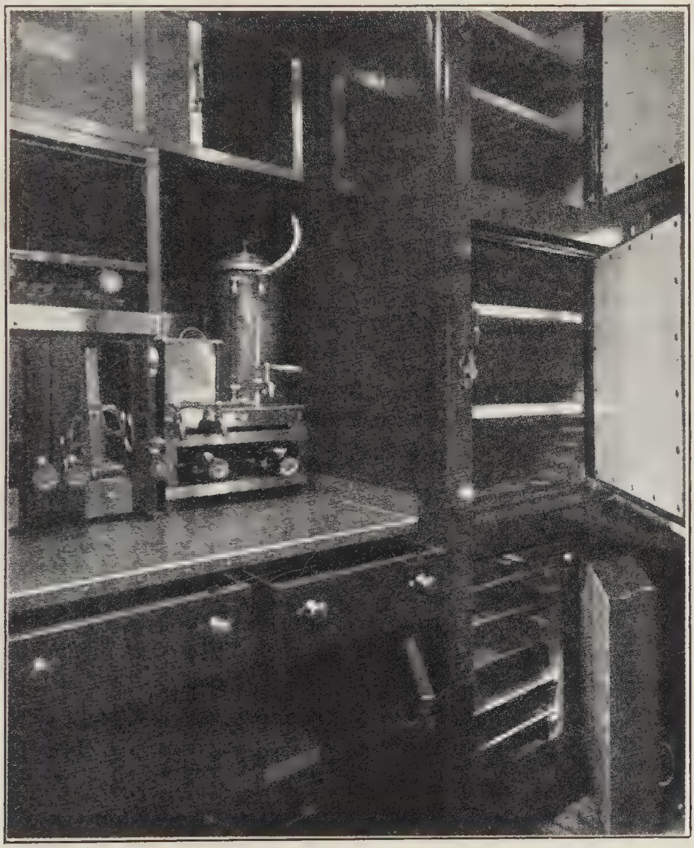

FIG. 214.—Kitchen of Pennsylvania café coach.

The Chicago & North Western has followed the Pennsylvania's example by putting in service a lunch counter car. This car has a counter running lengthwise of the car and occupying the entire length of the car except for a short kitchen at one end. There are seats for 27 persons. The car is used in connection with the "Golf Special" which leaves Chicago at 12:20 P.M. each week day and reaches a number of golf clubs on the north shore between Chicago and Waukegan.

On the European roads, when the coupé type of coach was in use[1] passengers could enter dining cars only at stations while the train was stopped. Because of this the very advantageous method—both for the operating roads and the public—still obtains of filling the dining cars to seating capacity, serving a regular course meal—followed by a second, third or even fourth sitting. Attachés of the dining car service pass through the train selling seats properly assigned for either the first, second or third sitting as the passenger may desire and as the accommodations will permit. In this way the passenger knows when he is to enter the dining car, and where his seat is—doing away with the awkward arrangement in this country whereby many persons will stand in line impatiently waiting and crowding the aisles. It has the additional advantage of enabling the service to be more smoothly and satisfactorily maintained, as the waiters are not required to serve oysters and soup to one passenger while carrying dessert and cheese to another. The ability to arrange commissary supplies and to cook and serve the meal quickly and satisfactorily following a regular prearranged line of procedure both as to courses and time, is far ahead of our "catch-as-catch-can" methods, for the reason, among others, that *table d'hôte* meals can be more easily

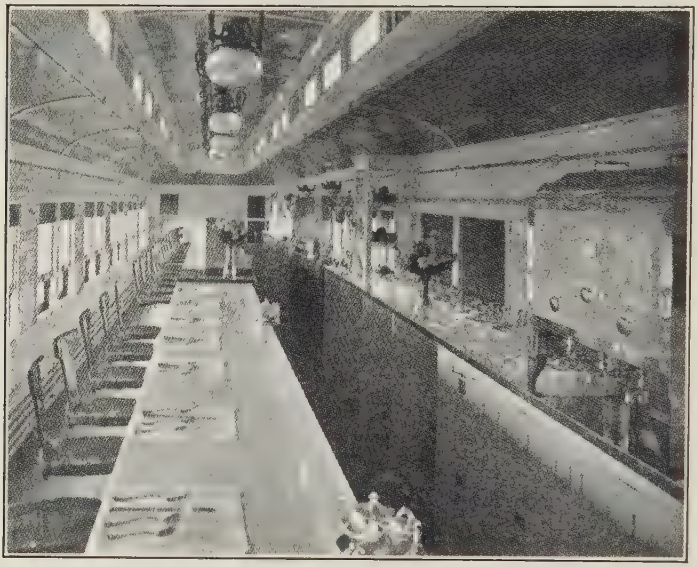

Fig. 215.—Chicago & North Western lunch counter car.

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[1] Now generally displaced on high-class trains by the so-called "corridor car."

served than *à la carte* meals under similar conditions. A general passenger agent, of much experience, who had given this great problem of the railroad dining car an unusual amount of study said:

"Eventually we are going back to the *table d'hôte* dinner, although the style and price of it must be regulated by food costs. It is the only practical dinner to serve in a restaurant where three cooks work in a kitchen 6 ft. by 18. The *table d'hôte* has hung on where competition for passenger traffic is simply heartrending. I doubt if a certain railroad could feed its tremendously heavy trains without the *table d'hôte* system. It is a practical sort of a meal because it makes for economical handling of time and space in the dining car. Did you ever stand in the aisle and hungrily watch a fellow linger over his dessert and then, just as you were about to snatch his chair, have him decide to linger over an after-dinner coffee? That is the mischief of trying to conduct a general café in a crowded car, with more than crowded facilities. The only way out of it is the *table d'hôte* for the high-class, high-speed trains and a revival of the eating house for the slower through express trains. That will take care both of the man who has a lot to spend on his meal and of the man who must watch his traveling expenditures carefully. Moreover, we will borrow a leaf from the English roads and serve the dinner in even relays and at set hours. The seat in the dining car will be numbered and you will have one reserved for you at a set hour, just as you reserve your parlor car seat today. It makes for kitchen order, kitchen discipline and a mighty well-pleased passenger."

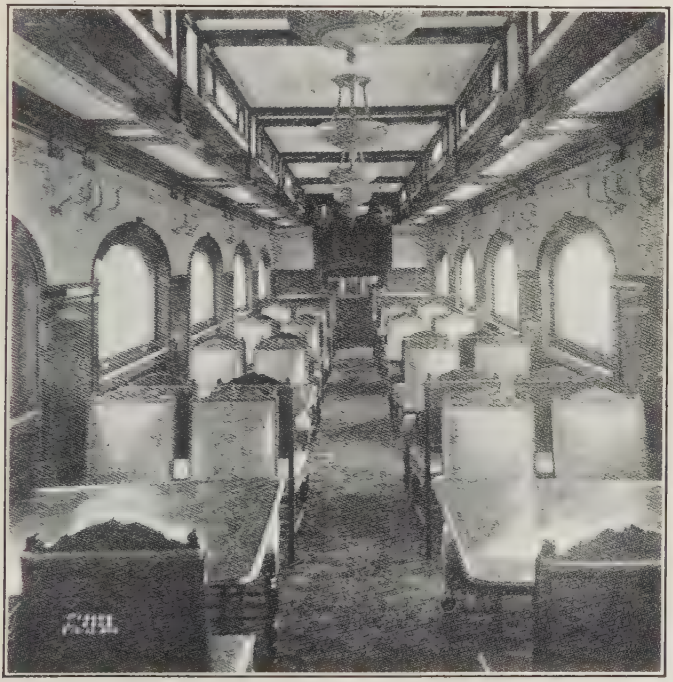

FIG. 216.—Interior of one of the latest New Haven dining cars.

A consideration of the relative merits of the two systems—*à la carte* and *table d'hôte*—will show, however, that even though the requirements may be more exacting upon the carrier there are conditions whereby the European plan is more desirable for the passenger. The United Fruit Company has recenty undertaken with success to introduce an *à la carte* dining service on a number of its larger and more modern ships (the Great White Fleet) plying between New York and Havana and Mexican ports. The facilities for preparing meals and the time at the staff's disposal for serving them renders the problem a comparatively easy one, although the undertaking was quite unique and demanded courage. Records indicate that on the New York-Havana trips, taking about four days each, the average check to a passenger is about $8.50, which is evidently considerably below what would be paid under the American plan.

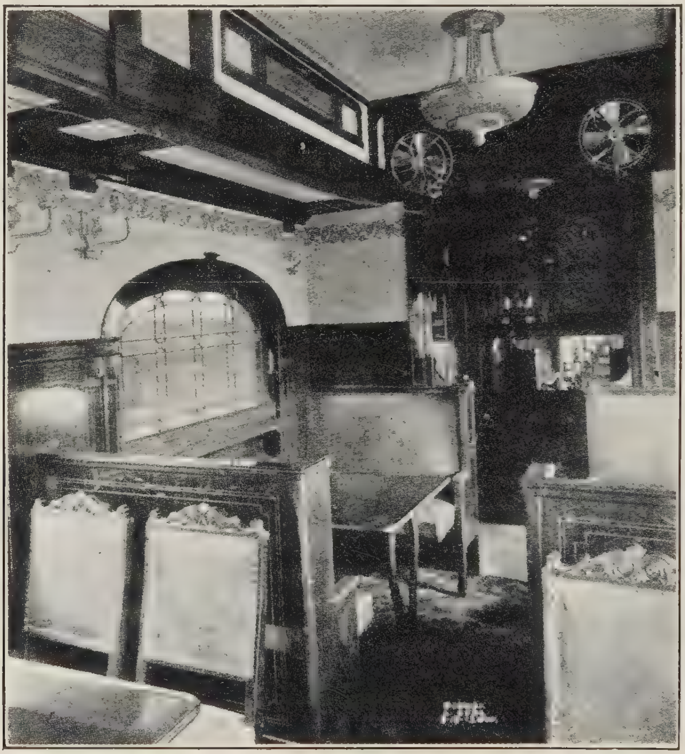

Fig. 217.—Serving counter of New Haven dining car, showing small space available.

It is of prime importance that proper sanitary precautions be taken both as to dining cars and their attendants. Most roads require a thorough physical examination of dining car employees every six months or oftener—and special examinations may be demanded in addition if there are reasons to suspect the existence of filth or disease. On the Pennsylvania system, every person having to do with the preparation or serving of food must undergo a physical examination every 30 days. No person with a trace of any communicable disease is employed or retained in the service. Some 1,100 men are employed on the system in dining cars and in its restaurants and even though each is examined monthly there are not infrequently cases where a dining car employee is examined three or four times a month.

To prevent that carrier of germs—dust—from reaching food intended for dining cars and restaurants, the Pennsylvania has adopted the practice of enclosing all meats in air-tight paper bags before removing them from the refrigerators in the storerooms. The rules under which the chefs handle such foods are as follows:

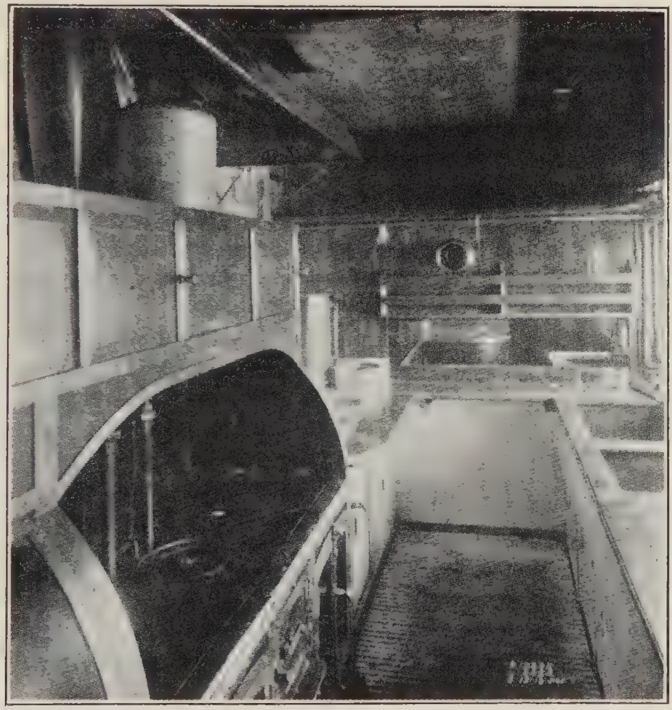

FIG. 128.—Kitchen of New Haven dining car.

"**Fresh Meats.**—Loins, roasts, lamb and mutton racks, veals, etc., drawn for outgoing trip, must be placed with bone or rib downward, on wooden rack at bottom of refrigerator; rack to be raised about 2 in. to allow air to circulate around meat.

"**Fish.**—This is the most delicate of supplies, easily affected by change of temperature; requires constant care, and should be kept in compartment of chill box next to sink, well packed in ice.

"**Fresh Vegetables.**—Asparagus, new beans, chives, green corn, green peas and kindred supplies, which are easily affected by change of temperature should be kept in locker next to milk compartment of chill box.

"**Condemnation.**—Supplies on hand at the end of trip must be carefully inspected by steward, chef and pantryman. Never serve supplies that are not in perfect condition. Food not in perfect condition must be taken to the Commissary for condemnation, for which car will receive credit."

The railroad dining rooms, restaurants and lunch rooms are no less interesting and important than the dining cars. It is a fact, however, that too commonly the railroad lunch room strikes the passenger as a necessary evil. In the lunch rooms on many roads the prices are too high, the food too stale or tasteless and the service too poor to gain the railroads any friends. There is room in this respect for all kinds of criticism and a great field for improvement.

Of course, there are exceptions. At the Grand Central Terminal in New York there are on the suburban level a dining room and lunch counter, both splendidly operated as a part of the station proper. There is also a satisfactory Thompson dairy lunch facing on the street and in addition a high-grade dining and lunch room operated by a tenant. The dining facilities in the new Kansas City Terminal are cared for by the Harvey system which is sufficient guarantee of their high standard. They embrace a first-class dining room where many of the city's business men get their meals; a more moderate priced, but good dining room; the usual quick lunch counter which has long since become an indispensable part of the American commissary, in addition to a basket lunch room. The main dining room has a seating capacity of 152 and the lunch room 250. An interesting detail in the operation of the lunch room is the use of the telautograph, by means of which the waitress transmits an order to the chef without being required to go to the kitchen until the food has been prepared. The order appearing on the telautograph in the kitchen is called off by the operator to the cooks and when the order is ready the cooks notify the operator who presses the proper button, thereby lighting a red light which indicates to the waitress that her order is ready. She thereupon goes to the kitchen for it. In this department alone there are 165 employees.

This Fred Harvey system which operates the dining room at the Kansas City Terminal also operates the dining cars and the lunch rooms over the entire Santa Fe system. It operates a large number of hotels at points along that railway's lines; it has the drug store, news stand, barber shop and other privileges at its stations and even the train boys on the Santa Fe trains obey its rulings. The Harvey system has a splendid and well-deserved reputation, and it is indeed far above the average.

Fred Harvey attained a position as leader in the art of serving the railway traveler inner man akin to that Webb C. Ball established for himself as the pioneer and pace maker in the work of creating, maintaining and inspecting railroad watches. It has been said that Fred Harvey started to establish himself by cutting a pie into four pieces instead of six and by his infinite attention to the vast details of feeding a traveling army so that each wanderer in that army might think that the meal had been cooked for his own single delight.[1]

Harvey made the Santa Fe system—or did the Santa Fe make Harvey? It was doubtless mutual coöperation. The Harvey system has now been on the Santa Fe for 40 years. It has endeavored to provide a service, by means of eating houses, lunch stands and dining cars in combination that would satisfactorily take care of the various classes of transcontinental passengers. It has always acted on one general principle—to please the passenger and make him a friend of the railroad the system serves, making its charges as consistent as possible with the service rendered.

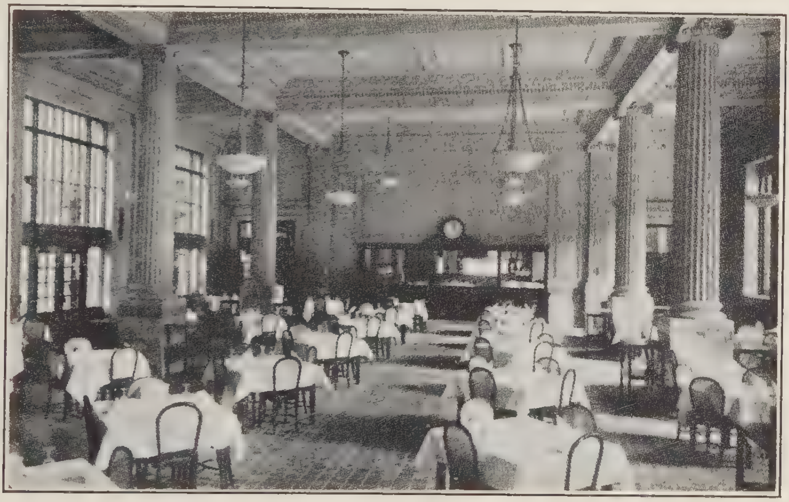

Fig. 219.—Dining room in North Western Station.

The Harvey system employs 4,800 persons. They are all carefully selected, trained and systematically—but humanely—supervised, and so good is their training that at least 48 of the Harvey graduates are now successful managers of first-class hotels. The system covers two great railroads—the Santa Fe and Frisco—thousands of miles of road, and maintains about 1,000 complete organizations, large and small. There is a staff of traveling superintendents and auditors, each of whom has a certain number of hotels or eating houses over which he exercises a certain control in his respective line. An inventory of equipment and non-perishable goods on hand is taken each month, and whenever a change of managers is made, the retiring manager checking to his successor. The supply consumption is heavy: in one year 6,700 head of cattle, averaging 1,300 lb. each on the hoof, were used; 2,000,000 chickens; 12,000,000 eggs; 257,000 lb. of coffee;[1] 1,100,000 lb. of sugar; 2,200,000 lb. of flour, 2,800,000 lb. of potatoes, etc. While several dairies are owned and operated, the bill for extra milk and cream averages $120,000 a year. In the Fred Harvey departmental guide for the government of the operating forces, there are listed 33 hotels and 68 lunch counters in Kansas, Arizona, Texas, California, Colorado, Oklahoma, Illinois, Missouri, Alabama and Tennessee.

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[1] Edward Hungerford, in the Saturday Evening Post, October 7, 1911.

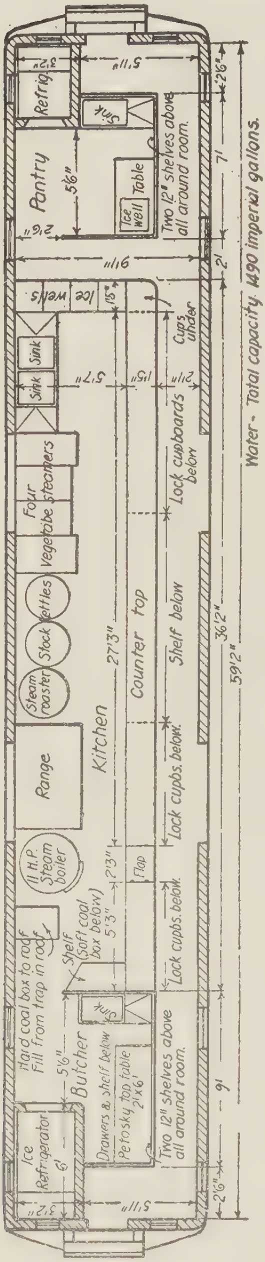

FIG. 220.—Canadian Pacific commissary kitchen car.

In the pamphlet, following each location, there are columns giving—in the case of hotels—the number of rooms with baths, and without baths, whether American or European plan; rates for one and for two persons, with or without baths; seating capacity of dining rooms and of lunch rooms; method of serving[2] with a "key" for other departments, interpreted: 1, for bar; 2, for barber shop; 3, for news stand; 4, news agency; 5, Indian room; 6, news storeroom; 7, soda fountain; 8, dairy; 9, farm; 10, livestock; 11, commissary; 12, drug store; 13, general store and 14, laundry.

Railroads are confronted more or less frequently with the necessity of housing, feeding and providing sleeping quarters for a large number of men with but little advance notice, as, for example, in case of a heavy snow storm, serious damage by flood or fire, labor trouble or unusual runs or diversions of freight. To meet such conditions, emergency hotel or boarding trains are usually provided. Typical trains of this kind are found on the Lehigh Valley and the New Haven. Three or more old coaches (usually not suitable for regular service) fitted up with sleeping bunks, mattresses and blankets form a part of the outfit. In each car there are 36 bunks, six tiers of three on each side of the car. The commissary is housed in a converted combination car, one end having tables and chairs seating about 40 employees. The other end holds the kitchen containing a large range, ice boxes, large coffee urns, supply closets, ample tank capacity for hot and cold water and frequently a gas range for light, quick work. A train of this kind can be made ready for service in 30 minutes after it is ordered; and it can be run to any point reached by rails. The writer has known upward of 500 meals a day to be served by the kitchen and dining car at a cost of less than 15 cts. a meal.

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[1] The coffee bill runs about $5,000 a month.

[2] Under meals, "T. M." (Train meals) *à la carte* or *table d'hôte*. Under lunch "short order" or "dairy."

The Canadian Pacific and the railroads in England and France were confronted with a similar problem when they were called upon to carry troops to points of mobilization. The Canadian Pacific's commissary kitchen cars were evolved when that road had to provide eating facilities on the trains carrying soldiers to the point of concentration at Valcartier. Regular baggage cars were used, the doors on one side being sealed and the cooking equipment being distributed along that side. Along the opposite side there was a corridor running along the full length of the car between the side of the car and a long counter over which food was issued to the orderlies who carried it to the soldiers in the other cars. Underneath this counter were kept the dishes, knives and forks and similar articles. The pantry and the meat supplies were at opposite ends of the car, each with its refrigerator, table and sink. The cooking apparatus, consisting of a range, a steam roaster, two stock kettles and four vegetable steamers was midway between along the closed side of the car. A small vertical steam boiler supplied the necessary heat. Fuel was carried in an iron box nearby, extending to the roof. The car had a total water storage capacity of 1,500 gal. in the form of tanks overhead and underneath the car. Underneath the floor there was also storage for vegetables. The crew of one of these cars consisted of a steward, 11 cooks and the steam boiler attendant. A car could prepare rations for 600 men three times daily.

CHAPTER XXII

STATISTICS OF PASSENGER SERVICE

The usefulness of certain statistics and the uselessness of others are facts more generally recognized today than ever before. There was a time when statistics were seldom used at all, but with the need of a closer check on all aspects of operation, their value has steadily increased. There are still some roads on which their use is limited, but the number of these is growing less each year. On the other hand, other railroads have gone to the other extreme and on them many reports of one kind or another are made which, though of interest, are of slight value. Statistics to be of value must be used for definite purposes. They prove of little consequence if the operating officer merely learns from them the cost per locomotive mile or per 1,000 ton miles and does not see wherein increased efficiency is needed and where steps must be taken to bring about improvement. This is a truth which sometimes escapes the notice of the over-enthusiastic statistician.

Freight service statistics have a relatively greater importance than passenger statistics not only because on nearly all roads the freight revenues are the larger, but because the operations of freight houses, yards and terminals are relatively more complicated. It is, of course, necessary to keep in close touch with the expenses at all passenger stations, but at all but the largest the expense is more or less fixed in character and varies so slightly with the traffic handled, that a study of changes in payrolls will usually tell the story quite clearly. At large terminals, however, especially when they are operated by a joint company controlled by two or more railroads, a more complete and comprehensive set of reports is necessary.

The information desired by the operating officer relative to passenger train operation may be divided into three groups:

(1) The efficiency of the service performed.

(2) The utilization of the equipment, and

(3) The cost of the service.

In the abstract, it may be said that the greater the volume of traffic the more essential are concise, illuminating statistical representations of the performance; the glasses through which the supervising offices may view the result of "the day's work" in the shortest possible time and in the most thorough possible manner. Where but few trains are run, personal and direct contact may be all sufficient, may be even superior.

The traveling public's opinions as to the efficiency of the railroad service are determined very largely by the percentage of days the trains on which it travels are on time. This, of course, is especially true of the commuter service, for a business man is likely to travel on the same train each day, and to arrange his own time so as to allow the least possible time between his home and his office. For that reason a delay to the train usually means a delay at his office. If his train causes him to be late each day he cannot be blamed for questioning the efficiency of the operating management which is unable to get its trains over the road on scheduled time. It is thus of the greatest importance, that all delays be carefully watched, that the causes be explained and that proper remedies be applied to prevent a continuation of them. This is a fact generally recognized and the daily delay report, in one form or other, is found on every railroad. The form and scope of the reports differ, however, because of differences in the character of the service performed, in the number of trains run, and in the importance of the trains.

On railroads where the through traffic is of greater importance and the local service of comparatively slight importance the delay report may cover only the important trains. On one important western road, a simple but comprehensive report is in use which shows the performance at a glance. On the left side of the sheet are the numbers of the trains, and across the top is the classification of delays. The delays number about 20 and include: late from connecting roads; terminal delay; engine failures; air hose burst; steam hose burst; getting steam through train; meeting and passing trains; trains ahead; rain storms and washouts; snow storms and blockades; handling baggage, express and mail at intermediate points, etc. Under each head there is shown for each train the minutes delay due to that cause. At the right the total delay is shown with the minutes made up The delays shown include not only the delays which caused the trains to be late at the terminal, but delays which have been made up. The latter are important, for at times they may cause serious delays, and if the superintendent or his superior does not know of them, he is not likely to take steps to prevent more serious trouble in the future.

In addition to the daily report there is a monthly summary of the performance of each train shown on the sheet. In this report a page is used for each train and a line for each day. At the end of the month each page shows the delays to its train by classes for each day and the average performance. In this way there is an excellent check and if for certain trains there are shown delays due to particular causes this fact is made apparent at once.

On roads where the important through trains can be counted by scores and the total trains by hundreds, a report of the kind described above is impossible or at least impracticable. A simpler one is necessary. The report made to the general operating officers of the New York, New Haven & Hartford shows what is needed on a road of this character. Here there are 80 through trains running over three main lines and all originating or terminating at Boston or New York.[1] The report is in two parts. The first shows the numbers of the through trains across the top and the important terminal and intermediate stations on the side. In the column for each train is shown the minutes delay if any, at each of the stations noted. This will show the length of delays en route and the amount of time made up as well as the time late at destination. In one corner is a summary giving the number of through trains run, the number five minutes or more late and the percentage of trains late. In another corner is a summary of the performance of all passenger trains on the system for the day. This shows separately by divisions the total number of trains run, the number and percentage five minutes or more late, the minutes late due to engine failures, and the number and percentage late due to being received late from other divisions or connecting roads. The second part of the report gives the explanation of delays to through trains, as many sheets being used as required.

In addition to this daily report there is also a monthly summary showing the delay each day to every train, the cause not being given. The report is kept in a loose-leaf ledger, one sheet being used for three trains.

A special daily report is made out for commuter trains. This is a telegraphic report received after the last commuter train has arrived. Thus by 10:00 A.M. the general superintendent is informed of the performance of the morning's commuter trains. The report simply shows the numbers of the trains and the minutes delay, no space being given to causes, and from it a monthly summary is made up which shows at a glance the performance of each train on each day.

Though the subject of train delays is vitally important and must be followed with the closest attention by the superintendent and the higher officers, the subject of cost of service is of equal importance. It is on this that a superintendent's performance is usually based and it is, therefore, of the greatest importance that accurate figures of direct costs be computed. Many factors entirely outside the jurisdiction of the superintendent will, of course, have their influence, but these factors can always be discounted.

One of the most important factors in determining cost is the utilization of equipment to the greatest possible advantage. This is particularly true of locomotives and passenger cars. The superintendent should know the average mileage made by the locomotives under his jurisdiction, and whether a large or small percentage of this mileage is light mileage. Of equal importance to the management is the distribution of passenger cars of all classes so that there will be few or no deadhead movements. Equipment represents heavy fixed charges and should produce as much revenue as possible. On the other hand, it is most essential that no unnecessary passenger cars be run on trains, for every additional car adds materially to the cost of handling that train. The operating management, therefore, should have information which will show it (1) the average mileage of the cars in service and (2) the average passengers per car for trains for the given period. The periodical report should include the average miles per locomotive per day both for the total engines assigned and for those in actual service. It should also show the amount and percentage of helping miles and of the mileage of light movements.

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[1] There are also some 1800 other passenger trains operated daily.

Turning to actual cost data, there are certain costs which are more or less easily apportioned to passenger service. These are locomotive repairs, fuel (or power), locomotive supplies, engine house expenses, enginemen and trainmen. The repairs may be under the jurisdiction of the division master mechanic or that of the shop superintendent reporting to the superintendent of motive power, in which case the superintendent may not be particularly interested. But he has jurisdiction as to all the other items and must keep close check on performance. It is difficult to arrive at an accurate cost for fuel, and this subject is being given the closest study on many roads at the present time. The assignment of engines and train crews likewise needs the closest attention and this is shown most clearly by the cost per train mile or per car mile. A statement is usually made showing the cost of these items based on the amount of service performed. The usual unit is the cost per locomotive mile, but it is of value to have, in addition, the cost based on the length or weight of the train—that is, the cost per car mile or the cost per 1,000 ton miles, the former being the preferable unit.

If a road is electrically operated a slightly different set of reports is necessary. On the New Haven a report is now being used which checks all the important phases of electric operation. The report covers freight, passenger and switching service, but only the part covering passenger service will be described. The first sheet shows the performance of the power house, the total cost and the cost per unit of output being given. The output is shown divided among the different classes of service, train propulsion, other company service, such as the lighting of stations, etc., and power sold to other companies. There are also shown the days on which the maximum and minimum output was made and the time and height of the maximum swing for the month. Lastly there are given the amount and cost of power purchased from other companies and the total amount and total cost of all power used during the month, both produced and purchased. The second sheet includes statistics of passenger train service. Statistics are shown separately for trains hauled by locomotives and trains using multiple unit equipment. The multiple unit service is divided into eastbound and westbound traffic. The service using locomotives is divided into four classes—express east, express west, local east and local west. With the service subdivided in this way it

THE NEW YORK, NEW HAVEN AND HARTFORD RAILROAD COMPANY, STATISTICS OF ELECTRICAL OPERATION—NEW YORK AND SHORE LINE DIVISIONS

For the month of September, 1915, compared with the month of September, 1914.

COS COB POWER HOUSE

	September, 1915		September, 1914	
	Total	Per kw. hr.	Total	Per kw. hr.
Coal consumed (tons)	10,497.24	3.06 lb.	11,428.08	2.86 lb.
Water consumed (gallons)	31,085,200	4.52 gal.	29,815,000	3.73 gal.
Cost of coal	$27,187.85	0.396 cts.	$31,312.94	0.392 cts.
Cost of water	932.47	0.013	3,137.70	0.039
Other supplies and expenses	634.05	0.009	617.21	0.008
Operating labor	5,579.18	0.081	6,452.50	0.081
Total Operating cost	34,333.55	0.499	41,520.35	0.520
Maintenance of power plant and machinery	11,396.71	0.166	4,347.27	0.054
Total cost (maintenance and operation)	45,730.26	0.665	45,867.62	0.574
Fixed charges (interest, taxes and insurance)	16,106.89	0.234	16,106.89	0.201
Total cost	61,837.15	0.899	61,974.51	0.775
Power consumption (kw. hr.):	Total	Per cent. of total	Total	Per cent. of total
Passenger service (electric locomotives)	3,610,795	35.7	3,003,821	37.6
Passenger service (M. U. cars)	574,896	5.7	388,359	4.9
Freight service	2,135,871	21.1	1,103,339	13.8
Switching service	1,219,886	12.0	632,376	7.9
Non-revenue service	10,923	0.1	26,828	0.3
Total used by elec. locos. and motor cars	7,552,371	74.6	5,154,673	64.5
Signals	128,240	1.3	112,300	1.4
Other company purposes	274,696	2.7	318,205	4.0
Line loss	376,570	3.7	574,595	7.2
Total used for company purposes	8,331,877	82.3	6,159,773	77.1
New York, Westchester & Boston	541,983	5.3	587,154	7.3
Other companies	1,252,900	12.4	1,246,473	15.6
Total power used (including Edison)	10,126,760	100.0	7,993,400	100.0
Power purchased from Edison company	3,255,400	....	....	....
Total power generated at Cos Cob[1]	6,871,360	....	....	....
Maximum daily output	Monday, Sept. 6, 295,340 kw. hr.		Saturday, Sept. 26, 312,050 kw. hr.	
Maximum swing	Thurs., Sept. 23, 5.57 P.M. 27,000 kw.		Fri., Sept. 25, 6.43 P.M. 27,900 kw.	
Minimum daily output	Wednesday, Sept. 1, 180,100 kw. hr.		Sunday, Sept. 6, 205,290 kw. hr.	
Average daily output	229,045 kw. hr.		266,447 kw. hr.	
Power purchased:	From NYC	From Edison	From NYC	From Edison
Power purchased (kw. hr.)	1,365,519	3,255,400	1,384,637	
Cost of power	$17,452.19	$27,693.73	$17,153.71	
Cost per kw. hr. (cents)	1.278	0.851	1.239	
Total Power:	A.c.	A.c. & d.c.		
Total power consumed (kw. hr.)	10,126,760	11,492,279	9,378,037	
Total cost of power (Inc. fixed charges)	$89,530.88	$106,983.07	$79,128.22	
Cost per kw. hr. (cents) (Inc. fixed charges)	0.884 cts.	0.931 cts.	0.844 cts.	

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[1] Cost figures based on power generated at Cos Cob.

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For the month of September, 1915, compared with the month of September, 1914.

PASSENGER TRAIN SERVICE

	Express trains				Local trains				Multiple unit trains			
	Eastbound		Westbound		Eastbound		Westbound		Eastbound		Westbound	
	Sept., 1915	Sept., 1914	Sept., 1915	Sept., 1914	Sept., 1915	Sept., 1914	Sept., 1915	Sept., 1914	Sept., 1915	Sept., 1914	Sept., 1915	Sept., 1914
Train miles	54,286	48,951	57,295	56,354	30,730	34,681	28,645	29,738	21,900	15,953	21,195	16,119
Locomotive miles	92,067	83,325	95,109	91,776	43,384	45,127	39,110	38,798	34,703	24,456	35,163	24,794
Car miles	437,740	398,602	492,864	454,350	184,160	196,919	168,604	179,045	83,193	62,454	86,575	62,721
Ton miles, trailing load	28,061,020	24,088,638	31,152,080	27,358,767	9,888,310	9,161,828	8,891,644	8,172,129	5,524,446	4,010,877	5,699,660	4,002,128
Ton miles, locomotives	11,185,566	@	10,641,355	@	4,491,341	@	4,338,512	@				
Kw. hr. used	1,172,031	1,156,025	1,282,794	1,299,178	718,490	748,344	620,101	664,818	312,235	242,536	346,254	227,995
Locomotive miles per train mile	1.70	1.70	1.66	1.63	1.41	1.30	1.36	1.30	1.59	1.53	1.66	1.54
Car miles per train mile	8.06	8.14	8.60	8.06	5.99	5.68	5.89	6.02	3.80	3.91	4.08	3.89
Kw. hr. per train mile	21.59	23.62	22.39	23.05	23.38	21.58	21.65	22.36	14.26	15.20	16.34	14.14
Kw. hr. per locomotive mile	12.73	13.87	13.49	14.16	16.56	16.58	15.85	17.14	9.00	9.92	9.85	9.19
Kw. hr. per car mile	2.68	2.90	2.60	2.86	3.90	3.80	3.68	3.71	3.75	3.88	4.00	3.64
Kw. hr. per 1000-ton miles*	41.77	47.99	41.21	47.49	72.66	81.68	69.74	81.35	56.52	60.47	60.75	56.97

OPERATING COSTS

	Locomotive repairs		Power		Locomotive supplies		Engine house expenses		Enginemen		Trainmen		Total	
	Sept., 1915	Sept., 1914	Sept., 1915	Sept., 1914	Sept., 1915	Sept., 1914	Sept., 1915	Sept., 1914	Sept., 1915	Sept., 1914	Sept., 1915	Sept., 1914	Sept., 1915	Sept., 1914
Trains hauled by elec. locomotives:														
Cost per train miles (cents)	10.12	20.99	25.19	19.51	0.69	0.66	0.61	0.52	8.68	8.85	9.96	9.96@	55.23	60.49@
Cost per locomotive mile (cents)	6.22	13.21	15.47	12.28	0.43	0.42	0.37	0.33	5.33	5.57	6.12	6.12@	33.94	37.93@
Cost per car mile (cents)	1.35	2.90	3.35	2.70	0.09	0.09	0.08	0.07	1.16	1.22	1.33	1.33@	7.36	8.31@
Cost per 1000-ton miles (cents)*	22.18	......	55.20	......	1.52	......	1.33	......	19.02	......	21.83	....	121.08	
Multiple unit trains:														
Cost per train mile (cents)	15.65	14.52	13.63	10.96	0.29	0.22	0.77	0.91	5.02	4.67	9.28	9.28@	44.64	40.56@
Cost per motor car mile (cents)	9.50	9.35	8.27	7.06	0.18	0.14	0.47	0.59	3.04	3.01	5.63	5.63@	27.09	25.78@
Cost per car mile (cents)	3.97	3.72	3.46	2.81	0.07	0.06	0.19	0.24	1.27	1.19	2.35	2.35@	11.32	10.37@
Cost per 1000-ton miles (cents)	60.09	......	52.36	......	1.13	......	2.95	......	19.27	......	35.61	....	121.41	

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* Ton miles based on trailing load. Locomotive repairs do not include charges on appropriation. Power includes cost per maintenance and operation of power plant but not fixed charges. Cost per 1000-ton miles not figured in September, 1914. @ September, 1914, figures revised, due to absence of necessary figures at that time.

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For the month of September, 1915, compared with the month of September, 1914.

FREIGHT TRAIN SERVICE

	Fast freight				Slow freight				Local freight			
	Eastbound		Westbound		Eastbound		Westbound		Eastbound		Westbound	
	Sept., 1915	Sept., 1914	Sept., 1915	Sept., 1914	Sept., 1915	Sept., 1914	Sept., 1915	Sept., 1914	Sept., 1915	Sept., 1914	Sept., 1915	Sept., 1914
Train miles	7,968	2,010	7,373	4,457	12,084	6,905	14,734	4,873	4,141	2,325	3,903	2,272
Locomotive miles	11,143	2,079	8,377	5,494	20,075	13,458	22,658	9,714	4,263	2,382	4,781	2,355
Loaded car miles	365,816	80,529	237,721	111,565	595,278	419,406	399,418	161,500	56,764	19,759	65,997	19,747
Empty car miles	2,776	201	27,736	73,951	35,122	22,687	363,846	206,757	37,848	7,599	33,911	8,999
Caboose miles	7,968	2,010	7,373	4,457	12,084	6,905	14,734	4,873	4,141	2,325	3,903	2,272
Ton miles—trailing load	13,908,267	2,780,062	7,737,370	4,681,138	25,259,851	17,680,370	20,421,464	9,283,447	2,559,705	775,474	2,888,278	864,030
Ton miles—locomotives	1,225,730	228,690	921,470	604,340	2,208,250	1,480,380	2,492,380	1,068,540	468,930	262,020	525,910	259,050
Kw. hr. used	333,481	64,482	220,943	143,637	627,445	424,500	664,061	274,686	160,965	78,963	151,464	66,793
Locomotive miles per train mile	1.39	1.03	1.14	1.23	1.66	1.95	1.54	1.99	1.03	1.02	1.22	1.04
Loaded car miles per train mile	45.91	40.06	32.24	25.03	49.26	60.74	27.11	33.14	13.71	8.50	16.91	8.69
Empty car miles per train mile	1.35	1.10	4.76	17.59	3.91	4.29	25.69	42.40	10.14	4.27	9.69	4.96
Ton miles per train mile*	1,745.52	1,383.11	1,048.06	1,050.29	2,090.35	2,560.52	1,386.01	1,905.08	618.14	333.54	740.01	380.29
Ton miles per locomotive mile*	1,248.16	1,337.21	923.65	852.05	1,258.27	1,313.74	901.29	955.68	600.45	325.56	604.16	366.81
Percentage of tonnage to rating, per cent	96	98	....	....	97	97	....	....	....	....	....	....
Ton miles per hour*	26,341	29,575	18,872	17,799	20,790	28,020	15,890	21,670	3,454	1,826	4,621	2,219
Average speed (m.p.h.)	15.09	21.39	17.98	16.95	9.95	10.94	11.46	11.38	5.60	5.48	6.24	5.84
Kw. hr. per train mile	41.85	32.08	29.97	32.23	51.92	61.48	45.07	56.37	38.87	33.97	38.81	29.40
Kw. hr. per locomotive mile	29.93	31.02	26.38	26.14	31.25	31.54	29.31	28.28	37.78	33.15	31.68	28.36
Kw. hr. per car mile	0.89	0.78	0.81	0.76	0.98	0.95	0.85	0.75	1.63	2.66	1.46	2.15
Kw. hr. per 1000-ton miles*	23.98	23.19	28.55	30.68	24.80	24.10	32.52	29.59	62.88	101.83	52.44	77.30

Percentage of tonnage to rating is found by dividing the total tonnage of trains as they leave Harlem River by the ratings of the locomotives hauling those trains. Ton miles per hour is found by dividing ton miles by the total running time of trains between terminals. Average speed is found by dividing train miles by the total running time of trains between terminals.

OPERATING COSTS

	Locomotive repairs		Power		Locomotive supplies		Engine house expenses		Enginemen		Trainmen		Total	
	Sept., 1915	Sept., 1914	Sept., 1915	Sept., 1914	Sept., 1915	Sept., 1914	Sept., 1915	Sept., 1914	Sept., 1915	Sept., 1914	Sept., 1915	Sept., 1914	Sept., 1915	Sept., 1914
Cost per train mile (cents)	13.36	16.81	31.99	27.73	0.33	0.95	0.37	0.69	12.31	10.80	16.11	16.11†	74.47	73.09
Cost per locomotive mile (cents)	9.02	10.82	21.60	17.85	0.22	0.61	0.25	0.45	8.31	6.95	10.87	10.87†	50.27	47.55
Cost per 1000-ton miles (cents)*	9.48	10.65	22.69	17.76	0.23	0.60	0.26	0.44	8.74	6.84	11.43	11.43†	52.83	47.52

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For the month of September, 1915, compared with the month of September, 1914.

LINE AND EQUIPMENT FAILURES

	Line failures																															
	Catenary insulator failures				Dead end failures				Other line failures				Equipment failures				Outside causes				Failures of employees				Signal failures				Total failures			
	September				September				September				September				September				September				September				September			
	1915		1914		1915		1914		1915		1914		1915		1914		1915		1914		1915		1914		1915		1914		1915		1914	
	No.	Total delay	No.	Total delay	No.	Total delay	No.	Total delay	No.	Total delay	No.	Total delay	No.	Total delay	No.	Total delay	No.	Total delay	No.	Total delay	No.	Total delay	No.	Total delay	No.	Total delay	No.	Total delay	No.	Total delay	No.	Total delay
Between Woodlawn and Stamford	1	....	4	66	6	....	1	26	2	16	3	41	..	....	1	8	4	165	3	10	3	136	..	....	1	395	2	31	17	712	14	182
Between Stamford and New Haven	3	....	1	4	1	....	..	....	..	....	5	85	..	....	7	36	2	9	..	....	..	....	2	97	..	....	..	....	6	9	15	222
On Harlem River branch	..	....	..	....	3	....	..	....	..	....	..	....	1	....	1	65	..	....	..	....	..	....	..	....	..	....	..	....	4	....	1	65
On New Canaan branch	..	....	..	....	..	....	..	....	..	....	1	59	..	....	2	3	..	....	..	....	..	....	..	....	..	....	..	....	..	....	3	62
In yards	..	....	..	....	8	193	..	....	2	....	1	....	2	....	..	....	1	....	..	....	..	....	1	....	..	....	..	....	13	193	2	....
Total	4	....	5	70	18	193	1	26	4	16	10	185	3	....	11	112	7	174	3	10	3	136	3	97	1	395	2	31	40	914	35	531

EQUIPMENT FAILURES

	Heated parts		Broken parts		Grounds		Miscellaneous		Total		Locomotive miles per failure		Ton miles* per failure		Minutes detention per failure	
	September		September		September		September		September		September		September		September	
	1915	1914	1915	1914	1915	1914	1915	1914	1915	1914	1915	1914	1915	1914	1915	1914
Passenger	3	4	3	4	7	15	4	10	17	33	16,385	8,155	4,587,827	†	19	13
Freight	0	0	0	3	0	1	3	2	3	6	33,410	7,499	23,591,645	†	88	36
Multiple unit—motor cars	2	0	1	1	2	0	7	3	12	4	5,914	11,042	935,342	†	13	10
Multiple unit—trailers	0	†	0	†	0	†	0	†	0	†	99,863	†	....	.....	0	0
Switch	0	0	0	0	0	0	0	0	0	0	54,245	30,084	....	.....	0	0

* Ton miles based on trailing load. † Compiled under the direction of Committee on Electrical Operation; J. A. Droege, chairman, H. Gilliam, G. O. Hammond P. J. Kearny, W. H. Foster, W. N. Polakov, J. McCabe, A. L. Ralson, Don Neiswanger, Secretary.

THE NEW YORK, NEW HAVEN AND HARTFORD RAILROAD COMPANY, STATISTICS OF ELECTRICAL OPERATION—NEW YORK AND SHORE LINE DIVISIONS

For the month of September, 1915, compared with the month of August, 1915.

SWITCHING SERVICE

	Locomotive repairs		Power		Locomotive supplies		Engine house expenses		Enginemen		Trainmen		Total	
	Sept.	Aug.	Sept.	Aug.	Sept.	Aug.	Sept.	Aug.	Sept.	Aug.	Sept.	Aug.	Sept.	Aug.
Cost per locomotive mile (cents)*	10.51	6.30	11.88	7.68	0.12	0.15	0.17	0.15	11.46	11.46	18.50	18.50	52.64	44.24
Cost per locomotive mile (cents)†	10.58	7.03	9.43	6.74	0.07	0.09	0.12	0.10	11.46	11.46	18.50	18.50	50.16	43.92
Cost per locomotive hour (cents)†	63.51	42.20	56.61	40.45	0.40	0.54	0.70	0.61	68.75	68.75	111.00	111.00	300.97	263.55

* Includes service of yard switchers, transfer engines and road switchers. † Includes service of yard switchers only, and excludes transfer engines and road switchers. The August figures for locomotive repairs and supplies, engine house expenses, and power have been revised.

LIGHT MOVES

	Number of moves		Locomotive miles		Per cent. light miles chargeable to shop		Per cent. light miles chargeable to service		Per cent. light miles to train miles		Per cent. light miles to total locomotive miles	
	Sept.	Aug.	Sept.	Aug.	Sept.	Aug.	Sept.	Aug.	Sept.	Aug.	Sept.	Aug.
Passenger—Electric locomotives	250	253	8,458	7,762	2.38	4.06	97.62	95.94	4.95	4.59	3.04	2.81
Passenger—M. U. cars	52	66	1,080	1,238	5.00	9.78	95.00	90.22	2.51	2.91	1.52	1.58
Freight	198	195	3,080	1,333	8.12	19.88	91.88	80.12	6.13	2.29	4.14	1.57

AVERAGE MILES PER LOCOMOTIVE PER DAY

	All locomotives		Serviceable locomotives	
	Sept.	Aug.	Sept.	Aug.
Passenger	183.63	179.56	214.98	215.48
Freight	105.88	108.07	122.96	129.69
Switch	113.01	116.21	129.15	123.95
Multiple unit	94.63	101.48	112.66	120.81

TOTAL LOCOMOTIVE MILEAGE

	Sept.	Aug.
Passenger	278,128	276,498
Freight	74,378	80,379
Train switching	2,826	4,440
Transfers and road switchers	22,959	26,034
Yard switching (0200–0215)	54,245	57,639
Work service	487	455
Total locomotive miles	433,023	445,445
Motor car miles (transportation)	70,947	78,646
Motor car miles (work)	26	....
Total motor car miles	70,973	78,646

Locomotives are classified according to types, not according to classof service. "All locomotives" includes total number of each class of service. Serviceable locomotives exclude locomotives out of service for repairs or inspection.

is possible to eliminate differences due to grade characteristics and those due to differences in the character of the service. For each of these six classes—both for the current month and the corresponding month of the preceding year—the following items are shown: (1) train miles; (2) locomotive miles; (3) car miles; (4) gross ton miles, trailing load; (5) ton miles, locomotives; (6) power used; (7) locomotive miles per train mile; (8) car miles per train mile; (9) power used per train mile; (10) power used per locomotive mile; (11) power used per car mile; (12) power used per 1,000 gross ton miles. The unit of locomotive miles per train mile is of greater importance than in steam service because of the extensive use of two small locomotives on heavy trains.

In addition to the statistics of performance, cost figures such as locomotive repairs, power, locomotive supplies, engine house expense, enginemen, trainmen and total cost are shown per train mile, per locomotive mile, per car mile and per 1,000 gross ton miles. These costs are shown separately for electric locomotive and multiple unit service.

A third sheet covers line and equipment failures. Line failures consist of failures of parts of the transmission system. These failures are divided into several classes, and are shown separately for different sections of the road, both main line and branches. Both the number of failures and the resulting delays to trains are given. Equipment failures are also classified according to causes and are shown separately for electric locomotives and multiple unit cars. The same information is shown for freight and switching service. The number of failures, the average delay, the locomotive miles per failure and the ton miles per failure are given for the different classes of service.

The fifth sheet includes a number of important factors affecting the efficiency of electric service. The first is the maintenance of transmission lines. Under this head are shown separately the costs of labor and material used in this service and also the cost of the service of the wire repair train, including wages of engine and train crews, cost of fuel, supplies, etc., in this service. These items are shown separately per mile of road electrified, per mile of track electrified, per mile of wire maintained, and per unit of power produced. The second item on the sheet is the cost of switching locomotive service, there being shown the cost per locomotive mile and per locomotive hour for the same items of cost as are shown for passenger service, repairs, power, etc. The third feature is light movement of locomotives or motor cars between stations or between stations and shops. The number of light moves is shown, the light mileage, the percentage of mileage required for service and the percentage required by engines going to or returning from shops, and the percentage of light mileage to train mileage and to total locomotive mileage. These items are shown for the different classes of service—passenger locomotives, motor cars and freight locomotives. The fourth item covers the average miles per locomotive per day for locomotives in the different classes of service. The average miles are shown separately for locomotives assigned and for locomotives actually in service, the latter figures excluding locomotives in the shops.

This report is described in some detail to give an idea of the factors in passenger service in which the operating officer is interested, to show some of the new conditions and problems to be met on electrified trunk lines and also because with a few changes, the form is applicable to steam operation. It is prepared under the direction of a specially appointed committee of electrical operation and placed in the hands of every transportation, mechanical and electrical officer interested. Opportunity of comparison with previous periods makes possible a close check on all aspects of operation. Sample reports are shown on pages 384 to 388.

As indicated in a general way at the beginning of the chapter the operation of stations and terminals cannot be checked in the same manner as the operation of trains. In the first place the expense does not rise or fall with the amount of traffic handled as in the case of most of the items in direct train service cost. The increase or decrease is often due to factors and conditions entirely outside of the service rendered and even beyond the control of the operating management.

The expenses of the small station are practically fixed. In addition to the agent there are certain clerks and attendants needed, but the number will change but slightly from month to month and even from year to year. If the station serves a summer resort, there will be a heavier traffic during the vacation months and additional labor will be needed, but this will be the only fluctuation in the labor expense. Changes of this character, however, are much more effectively checked by a study of the normal traffic at the station and the amount of work required. A cost per train mile or per passenger mile will give no idea as to the possibility of eliminating a man at that particular station. Each point should be considered on its merits by the superintendent and his superiors.

The same argument applies, but in a lesser degree, to the large intermediate stations. The pay-roll expense at these points will vary from month to month to some extent with the amount of traffic handled. But the operating cost of the station does not vary in the same proportion as the number of passengers or the amount of baggage and mail. The largest part of the expense is fixed, only a few items being appreciably affected, chiefly the cost of handling baggage. The cost, therefore, in this case as well cannot be checked by units, since one of the essentials of unit cost is that expense should vary directly with the number of units. Here again it is by a study of the pay-roll, the character of the service performed at the station and also the layout and design of the station and its facilities that the operating officer can best determine the efficiency of the station forces.

The traffic at a large terminal will vary widely from month to month or even from day to day. On holidays the number of passengers using the terminal facilities may be much in excess of the normal number passing through each day. Here, too, the seasonal changes will have an appreciable effect. But even in the large terminal the largest items of cost are fixed and unaffected by variations in the density of the traffic. Though more ticket sellers, additional attendants to direct and aid the travelers, extra men for the baggage and parcel rooms and increased forces in the operation of other facilities are necessary, the increases and decreases will be for the most part over long periods rather than in direct relation to the frequent fluctuations in the traffic handled. Moreover the proportion to the fluctuating expense to the total expense of the terminal is so small that a cost per unit of traffic is of little value. The superintendent of the terminal must be thoroughly familiar with each aspect of operation of the station; he must know what the capacity of the normal force is and how much more traffic than the normal amount it can efficiently handle. The design of the terminal is also of very great importance in efficient operation, and the official must study the means by which the operation of the station can best suit the characteristics of the plant. It is evident, therefore, that in the case of terminal as well as intermediate stations efficiency can be checked most effectively by total rather than by unit costs, by a study of the design, characteristics of traffic, and seasonal changes with the pay-rolls rather than by the cost of each item of expense on the basis of trains, passengers, and baggage handled.

When a terminal is controlled by two or more companies the expenses are usually divided on the basis of the cars and engines entering that terminal. The expenses of the Grand Central are divided in proportion to the sum of cars and engines entering in revenue trains, light engines entering, and cars entering for service from the passenger yard at Mott Haven. It is of the most vital importance, therefore, that an accurate check be kept by both companies on the total units of equipment entering the terminal limits. And it is most essential for each road to keep close watch on the utilization of equipment. If cars leave the terminal empty or enter the terminal empty that company is paying out just that amount more of terminal expense than is necessary, unless the movement of that car is necessary to cover heavier traffic in the opposite direction. It is the common practice at all terminals to keep a count of passengers in and out on trains, but the New Haven road has recently introduced a set of records which will indicate even more clearly whether cars can be left off trains or whether more cars must be added. The latter is just as important, for the railroad's passengers with justification demand seating room for all.

The system of records is simple enough. The conductor, of each train both into and out of the terminal turns in a report showing the number of the train, engine number, numbers of the coaches and the names of the Pullman cars. Beside each car number is shown the number of passengers in that car as the train left or arrived at the terminal. These slips are then recorded on forms in the train master's office. The form shows on the left side the numbers of the train, enough sheets being provided for all trains. The form is divided into four columns, headed coaches, capacity; coaches, number of passengers; Pullman cars, capacity; Pullman cars, number of passengers. When the form is made out one can see at a glance the car capacity of coaches and Pullman cars for each train with the numbers of the passengers carried on those coaches or Pullman cars. At the end of each month the results are transcribed to a second form. This shows, on the left side, the days of the month and across the top the same items as for the other form, capacity of cars and passengers carried for both Pullman cars and coaches. From this the performance of each train for a month is seen and the necessary information is given at once as to whether the trains are regularly crowded or are carrying more cars than necessary. From this simple method the trainmaster at the terminal and his superior officers are kept currently informed of the loading of cars at the terminal and can check the efficiency in this direction.

But not only is the number of cars a factor, but the number of engines; both those in trains and light engines enter into the count of units of equipment entering the station. It is necessary, then, that a close check should be kept of engine movement. On the New Haven where two small electric engines are needed to haul heavy trains, care must be taken to prevent doubleheading when one engine could handle the service. Light moves are more numerous when there is heavy traffic in one direction at a certain period of the day, and therefore, records are required to show the light moves—both into and out of the terminal with the reasons for each move. It is only by these records and by constant analysis of them that unnecessary movements are eliminated and that each road's proportion of terminal cost is kept at the minimum.

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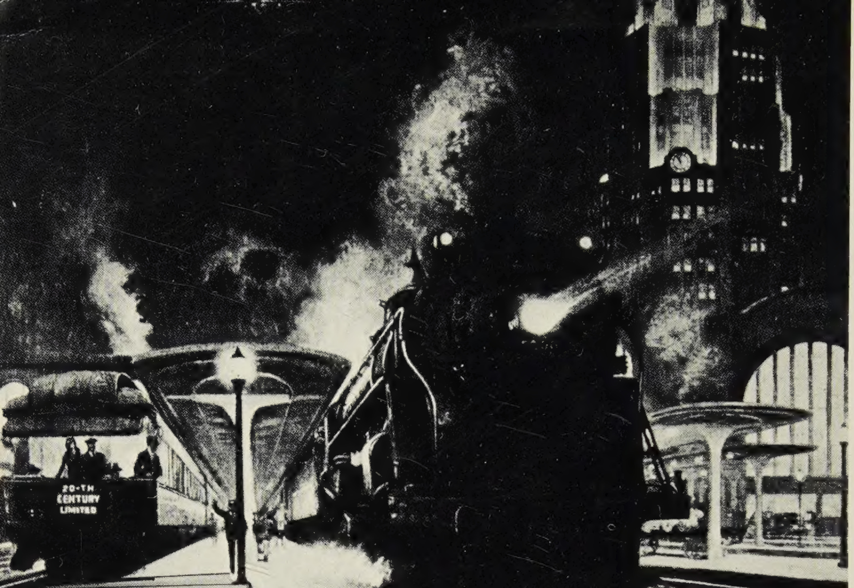
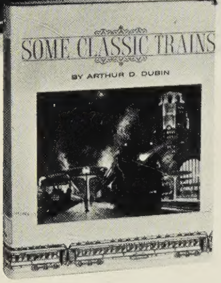
John A. Droege

PERHAPS "a railroad-man's railroad man" is the best description of John Albert Droege, and doubtless the summation he would have approved. He was born in Deer Park, Md., the year the Civil War began and was credited with no formal education. He went railroading in 1880 as a telegrapher for the Baltimore & Ohio, and by the turn of the century he had worked for Chesapeake & Ohio, Norfolk & Western, East Tennessee, Virginia & Georgia (later SR), and Southern in jobs ranging upward from stenographer to dispatcher to yardmaster to trainmaster. He joined Lehigh Valley in 1899 and was a division superintendent by 1900. Droege went to the New Haven as a super in 1904 and was vice-president and general manager of that system when he concluded a half-century-plus of active railroading in 1931. Trains apparently had agreed with Droege, for he lived to age 100, before passing away in Orlando, Fla., on March 5, 1961. He authored a total of four texts on the railroad industry.

DUST-JACKET PHOTO: Veteran Pacifics prepare to depart the west shore of the Hudson with a battery of afternoon rush-hour commuter trains from Erie's famous old Gould-era station in Jersey City, N. J.





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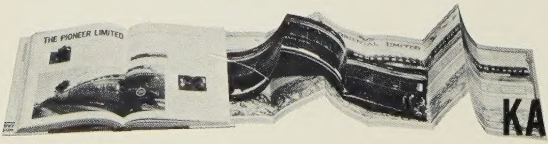

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